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TECHNICAL LETTER NASA-37

U.S. Geological Survey
Department of the Interior

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WASHINGTON, D.C. 20242

Technical Letter
NASA - 37
August 1966

Dr. Peter C. Badgley
Chief, Natural Resources Program
Office of Space Science and Applications
Code SAR, NASA Headquarters
Washington, D.C. 20546

Dear Peter:

Transmitted herewith are 2 copies of:

TECHNICAL LETTER NASA - 37

PRELIMINARY ULTRAVIOLET REFLECTANCE OF SOME ROCKS AND MINERALS FROM 2000Å to 3000Å*

by

A.N. Thorpe, C.M. Alexander, and F.E. Senftle

Sincerely yours,

William A. Fischer
Research Coordinator
Earth Orbiter Program

*Work performed under NASA Contract No. R-146-09-020-006

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UNITED STATES

DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

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by

A.N. Thorpe, C.M. Alexander, and F.E. Senftle**

August 1966

These data are preliminary and should not be quoted without permission

Prepared by the Geological Survey for the National Aeronautics and Space Administration (NASA)

*Work performed under NASA Contract No. R-146-09-020-006

**U.S. Geological Survey, Washington, D.C.

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Preliminary Ultraviolet Reflectance of some Rocks and Minerals from 2000 Å to 3000 Å

by

A. N. Thorpe, C. M. Alexander, and F. E. Senftle

INTRODUCTION

In order to appraise the concept of using the solar reflectance to determine the composition of the rocks, preliminary studies were undertaken by the U. S. Geological Survey. In the interest of speeding up the investigation, some initial measurements were made with the aid of existing equipment, both to determine the extent of the problem and also to evaluate the problems to be encountered in a more detailed study.

General scope of preliminary studies

About 40 specimens of rocks and minerals (including those types anticipated on the lunar surface) were selected for study. Reflectance measurements were made to see if there were any broad differences or other distinguishing features which could be used for identification purposes.

Sample preparation: The specimens were sawed into 2" X 2" X 0.5" squares. One face was cut and polished, but the degree of polish was not accurately controlled. In a few cases, slightly smaller samples were used.

Instrumentation: A 1/2 meter, grating type, McPherson spectrophotometer was used for the measurements. The grating was blazed at 1500 Å (1200 lines per mm), and the resolution was less than 1 Å between 1850 and 3050 Å. An EMI photomultiplier tube specially selected for low dark currents and high sensitivity was used. The tube also had a sodium salicylate coated window. The detector assembly was a standard

McPherson No. 650. The specimen was mounted with the polished face toward the entrance slit such that the angle of incidence was about 15°. Thus, polarization effects were kept to a minimum. A deuterium discharge lamp was used for a light source.

Experimental measurements: The spectrophotometer was calibrated by moving the light source directly in front of the entrance slit. The spectra recorded in this way were used to correct the sample data. The specimen was then placed in a rigid holder about 2 to 3 inches in front of the slit with the light source in the normal position. Essentially the whole surface of the sample was uniformly illuminated but due to the solid angle subtended by the entrance slit only a small portion (about 3X10 mm) of the sample was observed. Any one of these small areas was quite reproducible but due to grain size and compositional variation the spectral response would change somewhat if another small area was observed. A highly polished copper plate was subsequently run as a standard. The data of Ehrenreich and Philipp (1962) on polished copper were used to reduce the data to absolute reflectance.

Results and discussion: The corrected data are shown in the Appendix. In general the reflectance increases slightly at the shorter wavelengths and takes a sharp drop around 1900 Å. The spectra show few pronounced peaks, and hence it is concluded that there is no significant fluorescence in the part of the spectrum measured. For comparison, see the typical fluorescence peaks shown for synthetic CsI in Figure 1.

There are a few small peaks and fine structure in some of the specimens, however, which are quite reproducible provided that the same area of the sample is observed. In part this structure may be due to a minor amount of fluorescense, but from some experiments made on a few samples, it was shown that the degree of polish seriously influences the fine structure reflectance. For valid comparison of the reflectance of rocks the degree of polish must be carefully controlled.

To attach a crude numerical value to this gradual increase in reflectance, a slope factor, M, was calculated as follows:

$$M = \frac{R_{2250} - R_{2750}}{R_{2500}}$$

where the R's are the reflectance at the specified wavelengths. The results shown in Table 1 are not very diagnostic. All the nine granites and quartz monzonites measured had positive values whose averages were $\sim$ 0.08 and 0.07 respectively. The three granodiorite and basic rocks measured had both positive and negative slopes. Although the average data show a trend, the data are scanty. There does not seem to be a sharp distinction in the slope of the reflectance spectrum of acid and basic rocks in this part of the ultraviolet spectrum.

The sharp attenuation of the reflectance in the neighborhood of 1900 $\mathring{A}$ is undoubtedly due to the presence of oxygen, mainly in the form of SiO_2. However, oxygen in any form, e.g., see spectrum of mica, will cause a similar drop in reflectance. It is significant

that the minerals, e.g., fluorite, which contain no oxygen, do not show this drop and in general show less fine structure throughout the range studied.

Reference

Ehrenreich, H., and Philipp, H. R., 1962, Optical Properties of Ag and Cu: Physical Review, v. 128, n. 4, p. 1922-1629.

Table 1. The slope factors for various rock types.

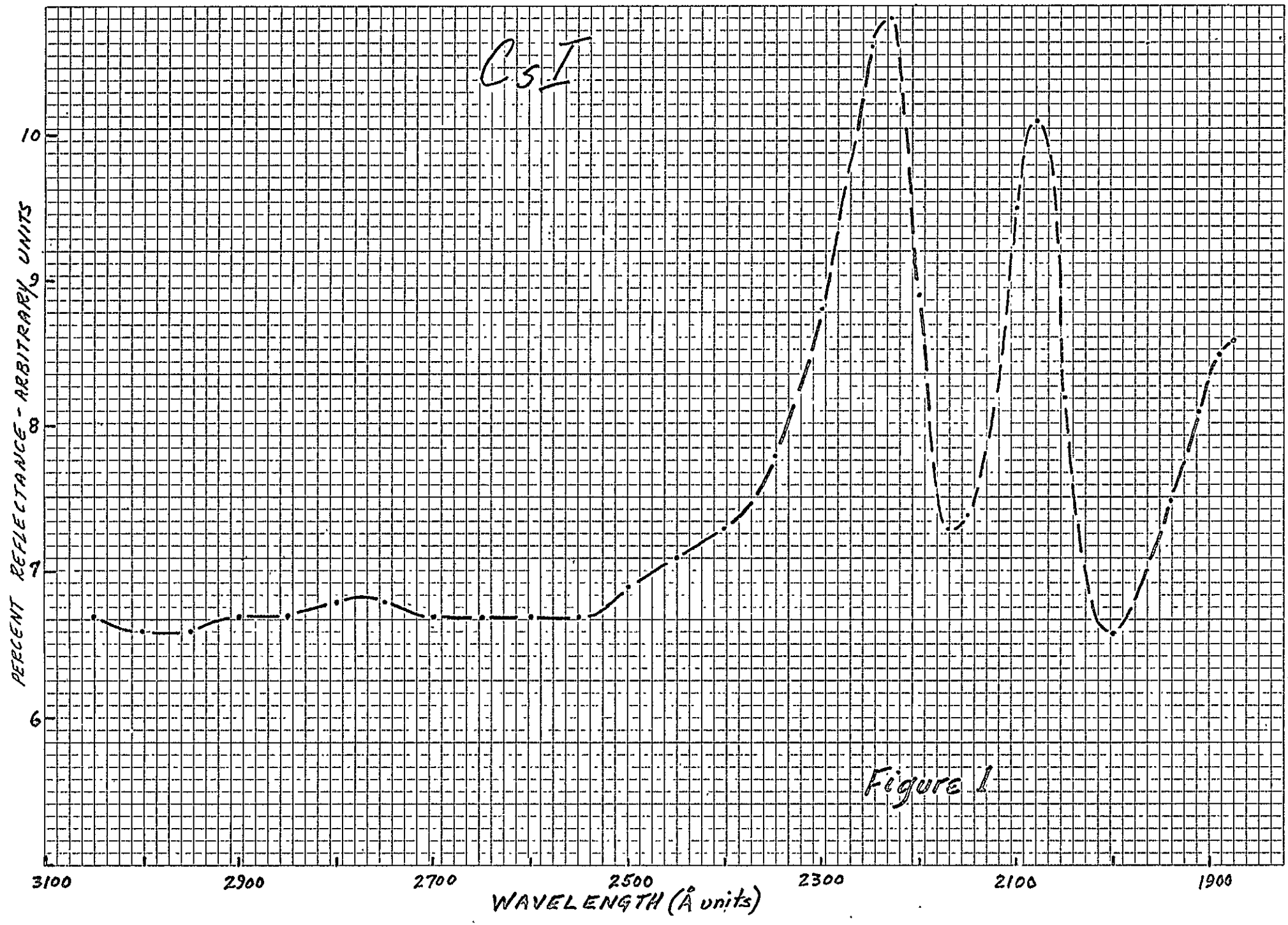
Granites		Quartz Monzonites		Granodiorites	
No. 300	0.036	No. 269	0.077	No. 315	-0.027
301	0.061	316	0.065	323	0.198
302	0.179	320	0.081	353	-0.005
303	0.146	352	0.051		
304	0.179				
305	0.066				
306	0.008				
307	0.024				
355	0.000				

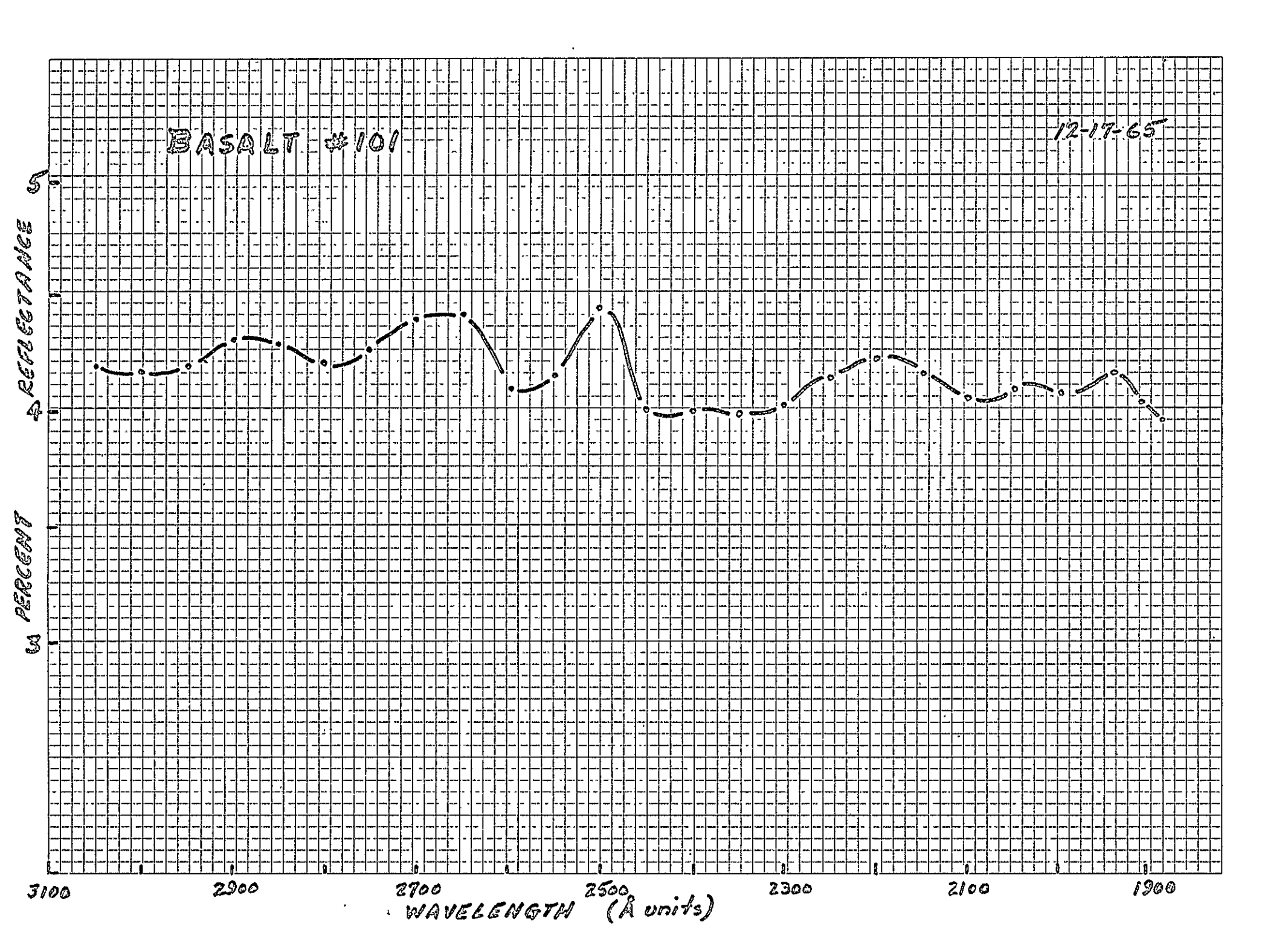
Basic Rocks

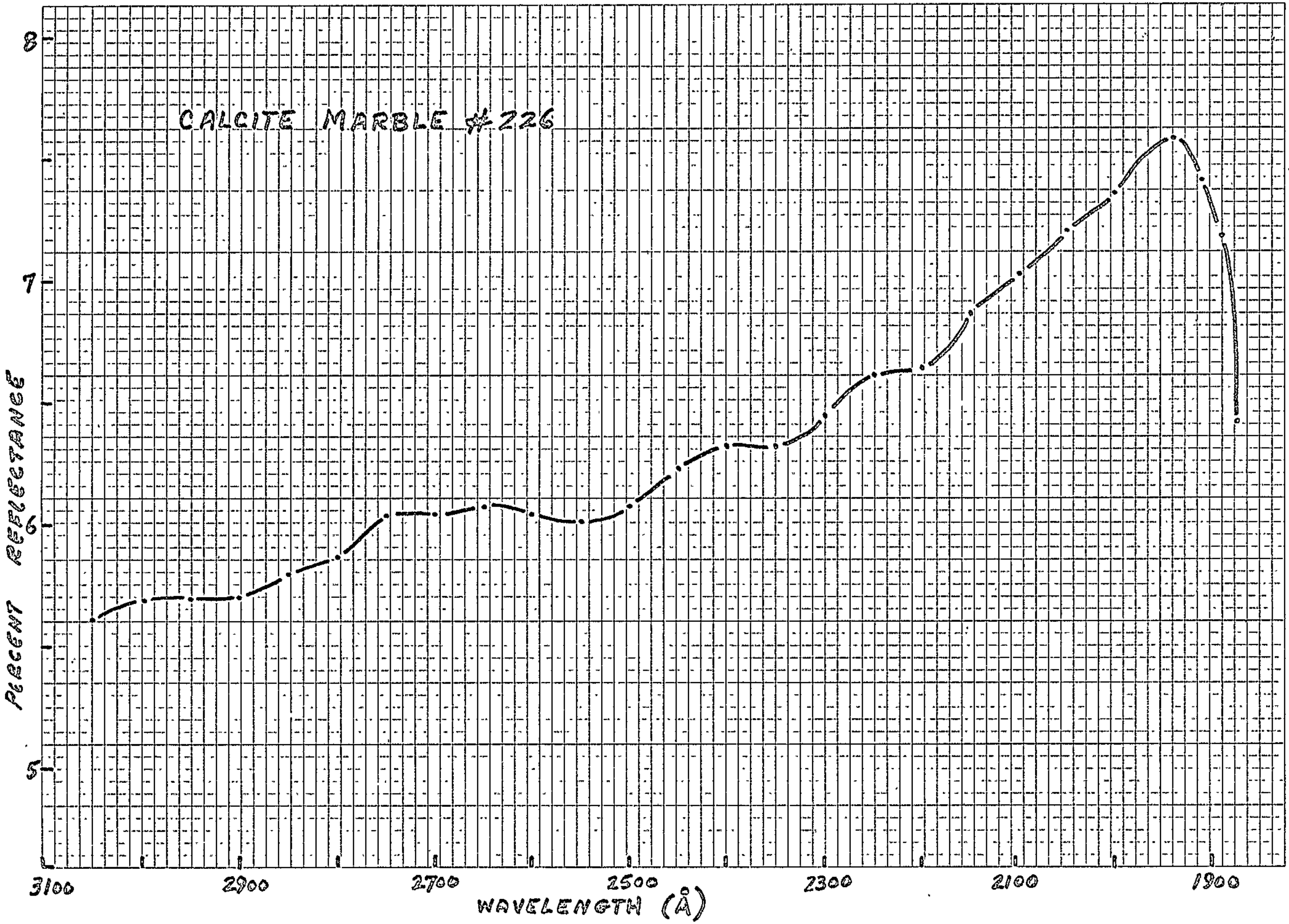
Basalt	No. 101	-0.027
Diabase Porphyry	No. 270	0.097
Gabbro	No. 308	0.052

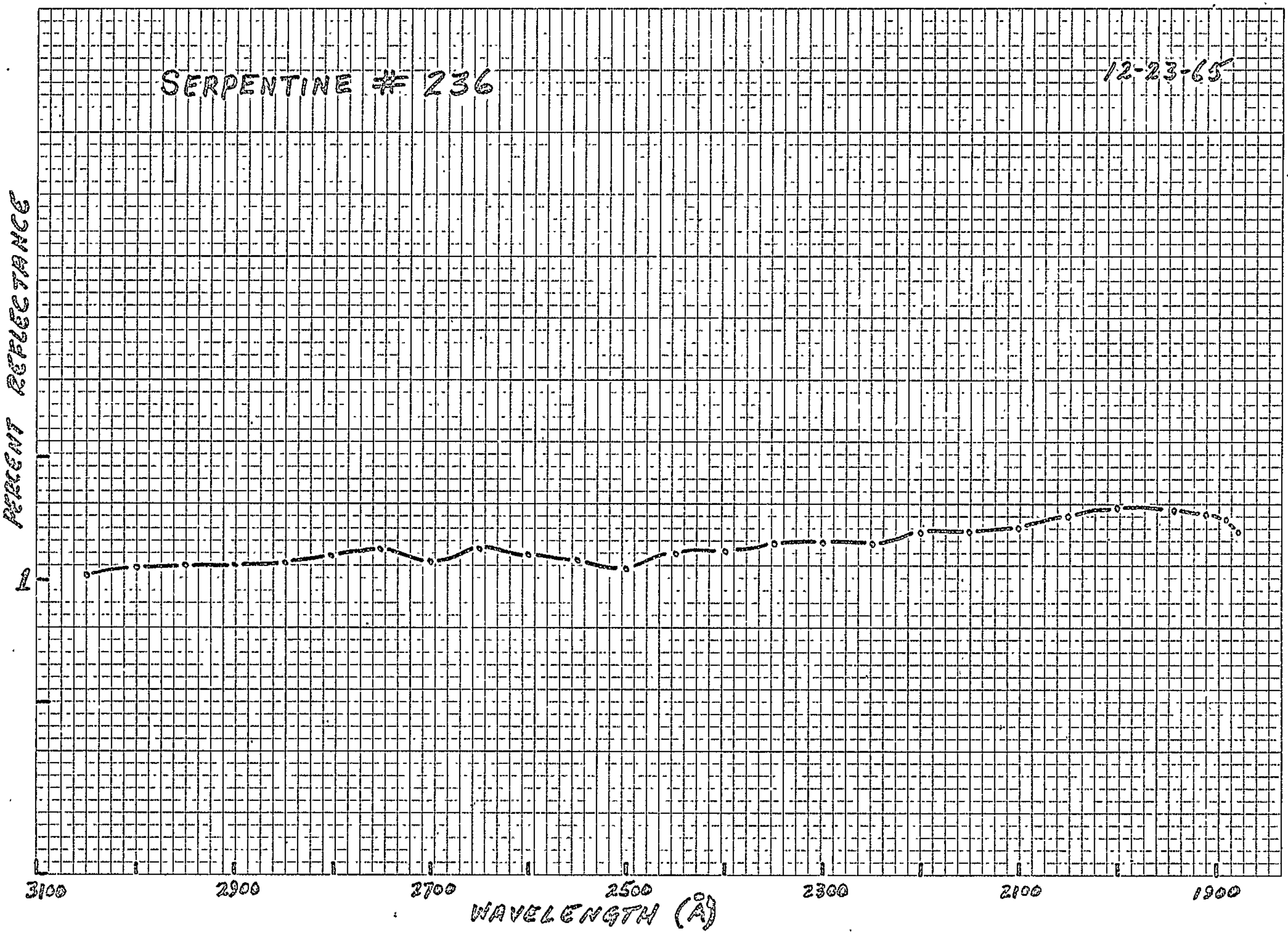
Average Slope Factors

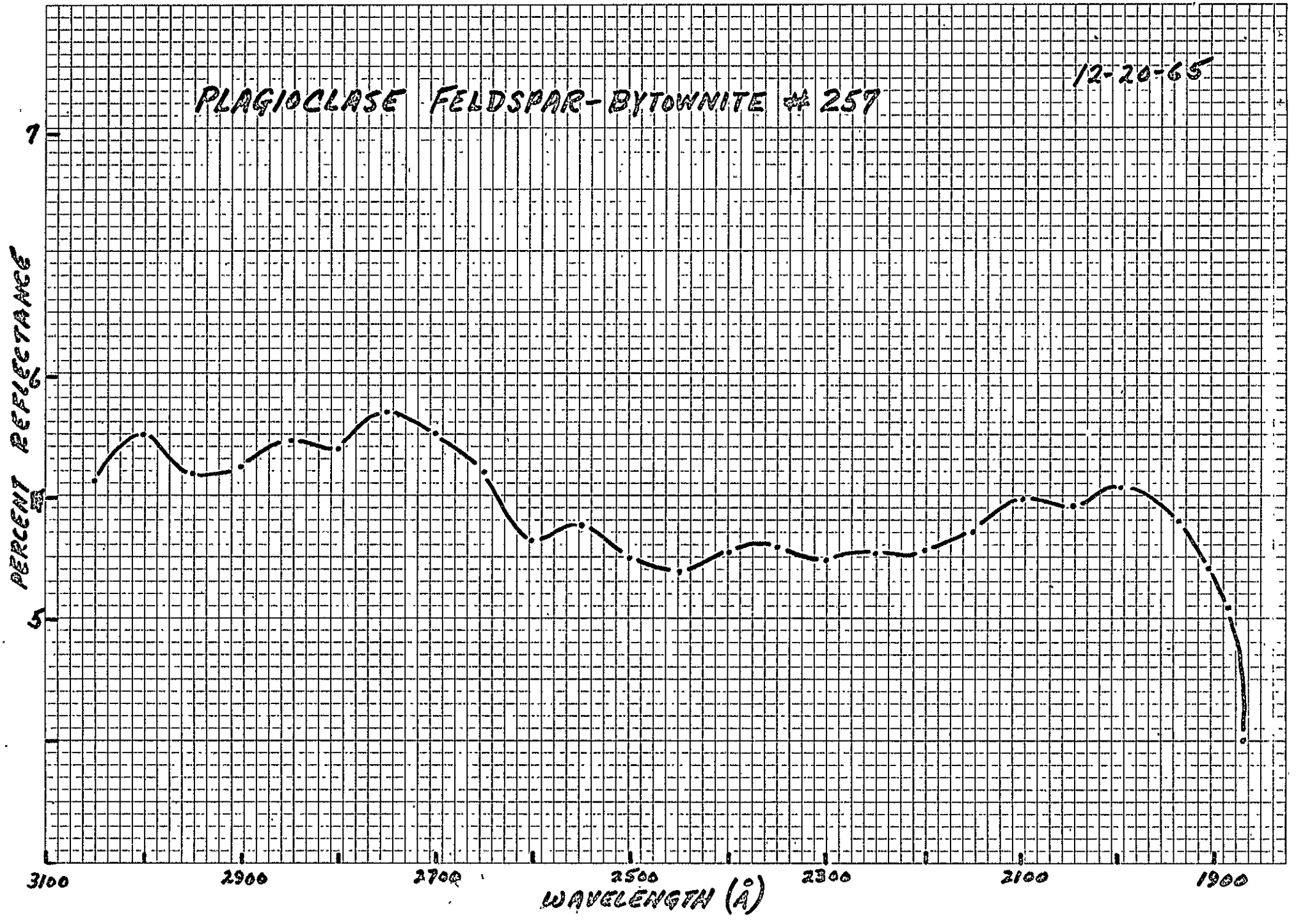
Granites	0.078
Quartz Monzonites	0.068
Granodiorites	0.064
Basic Rocks	0.050

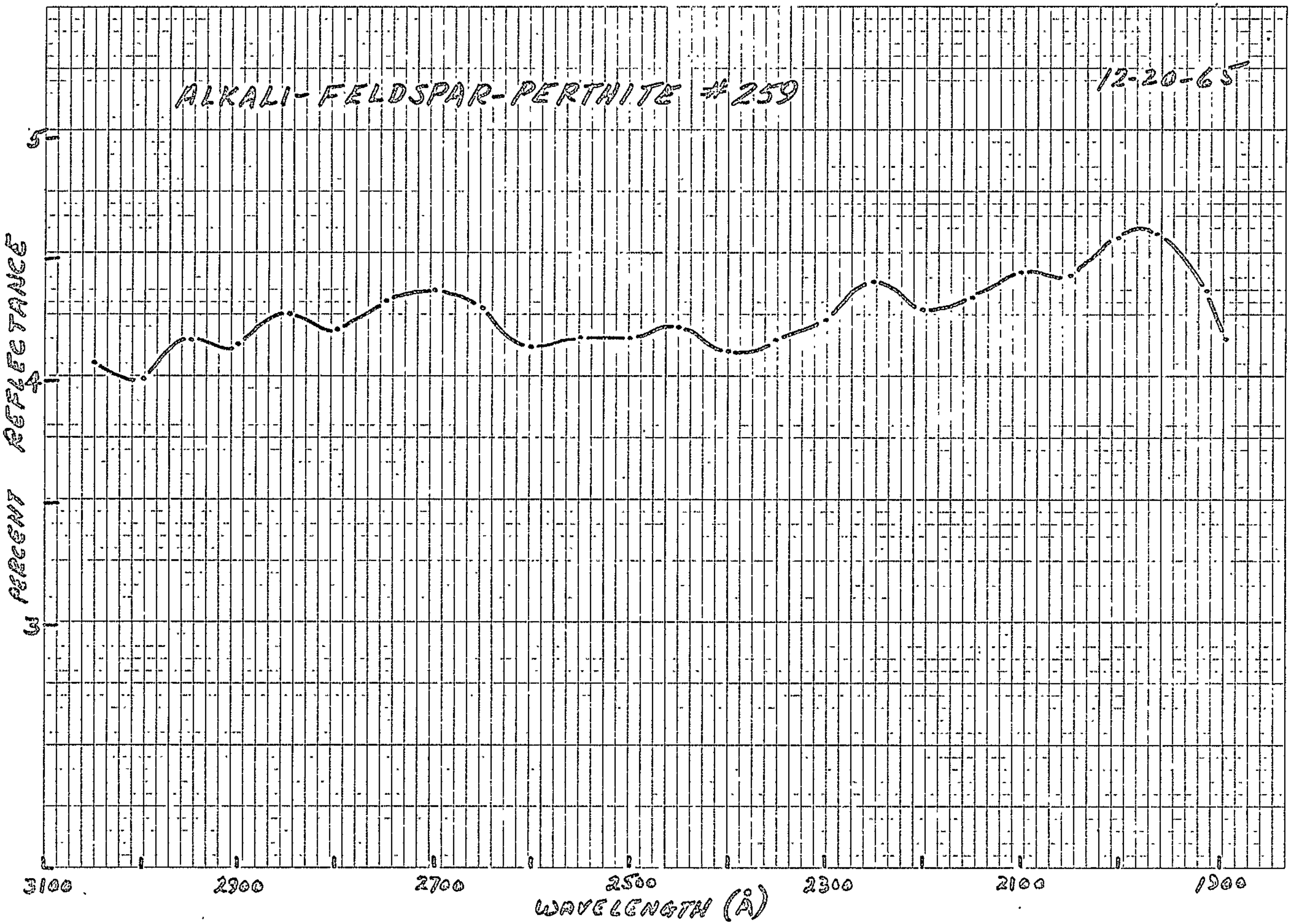


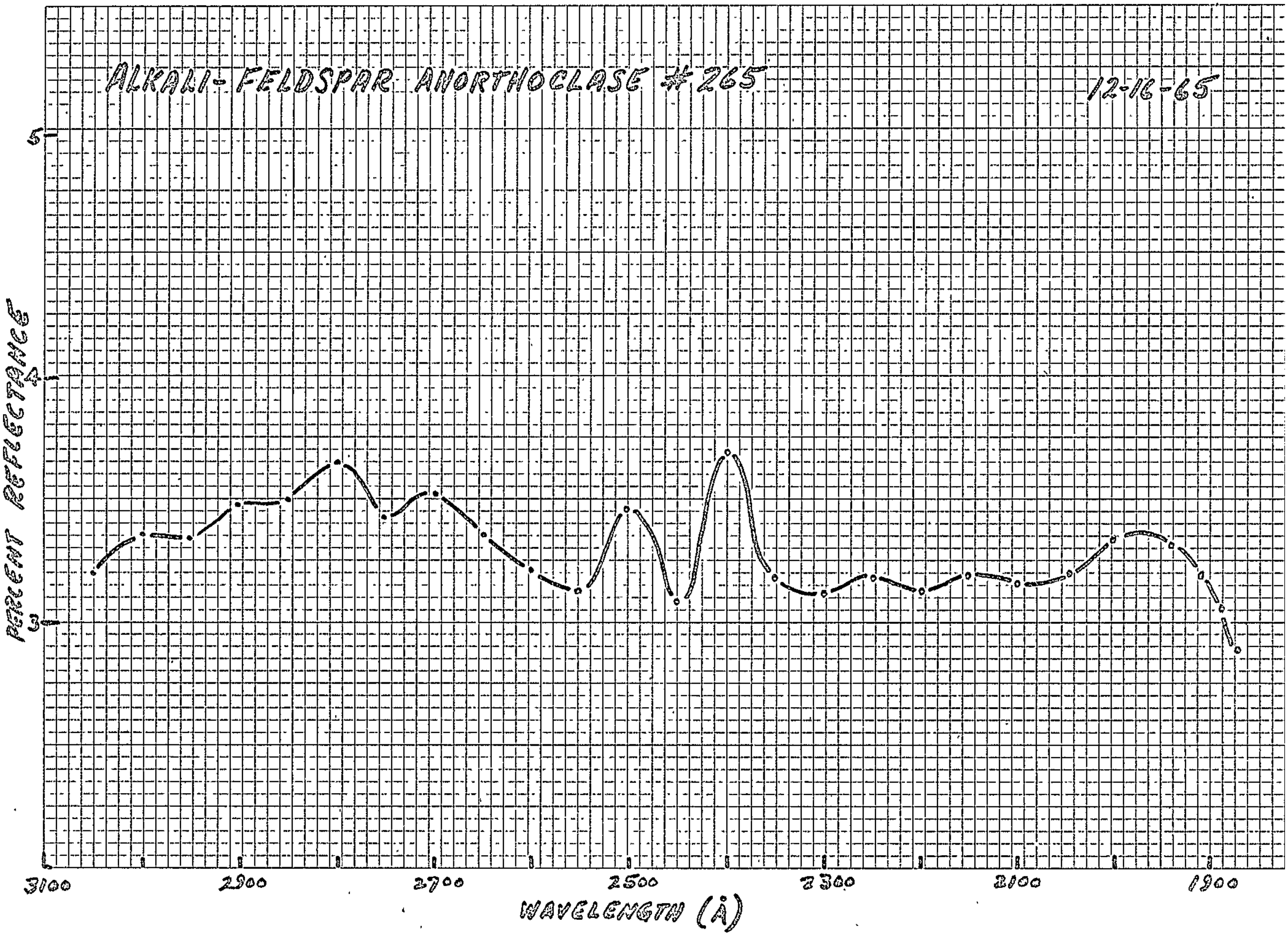


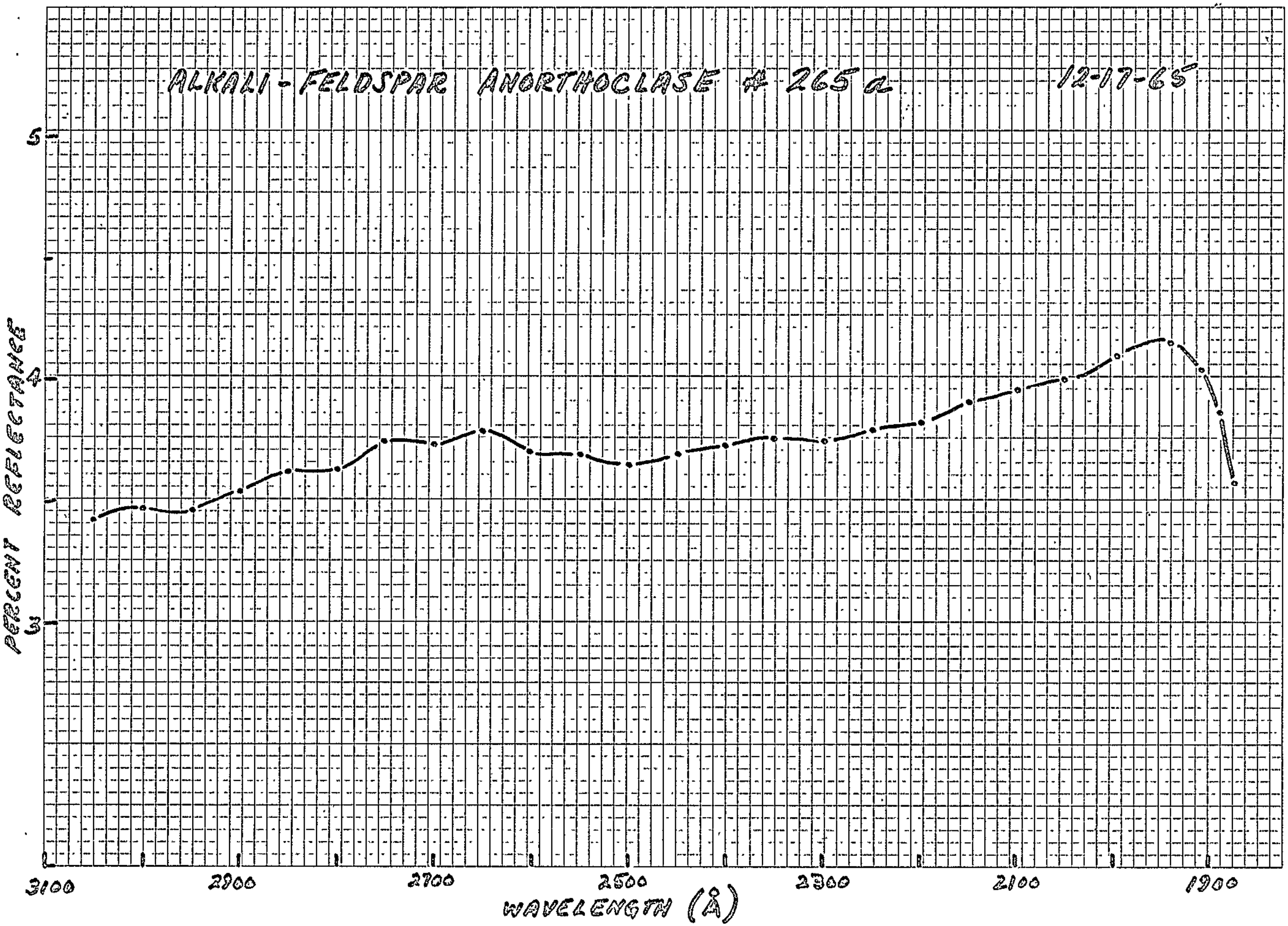


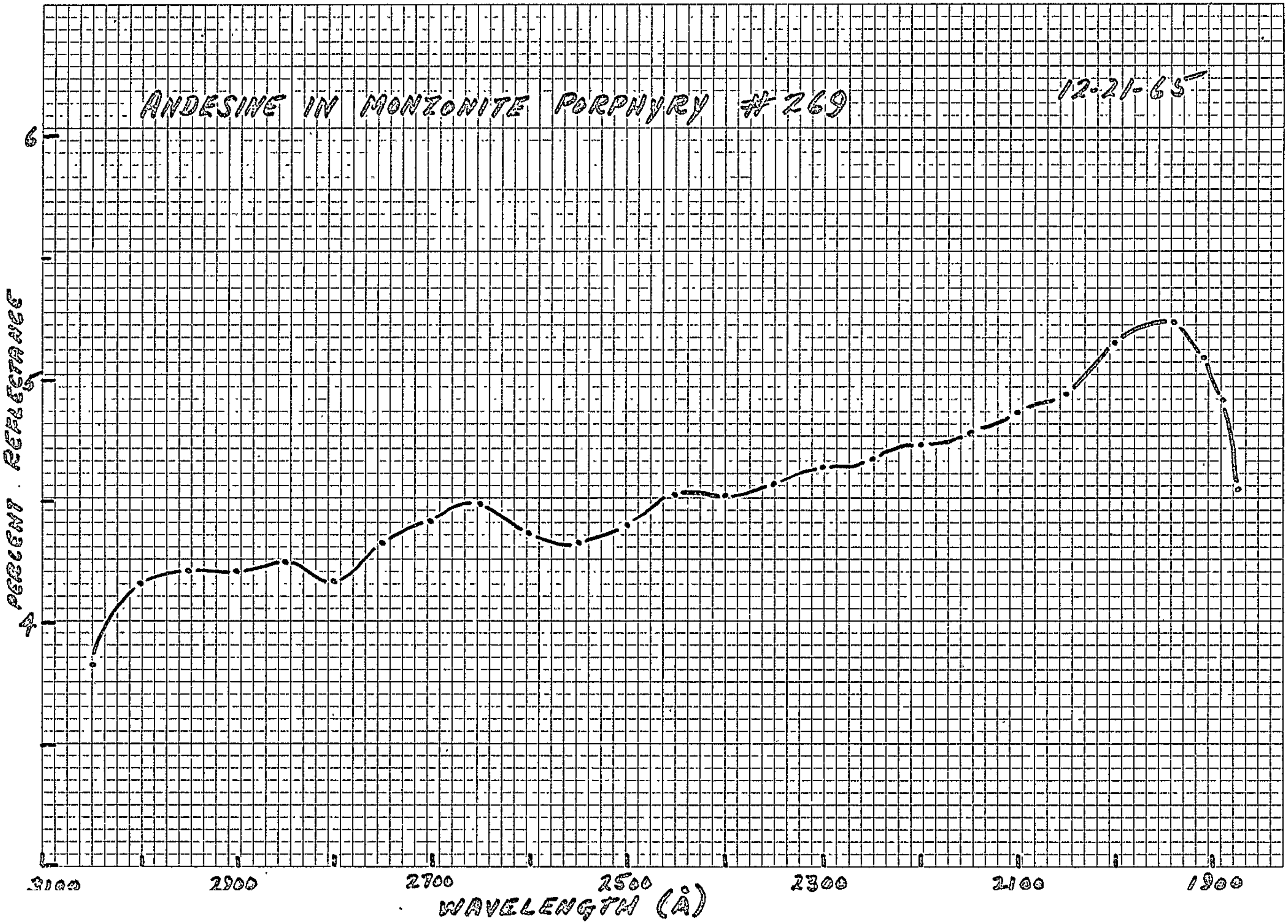


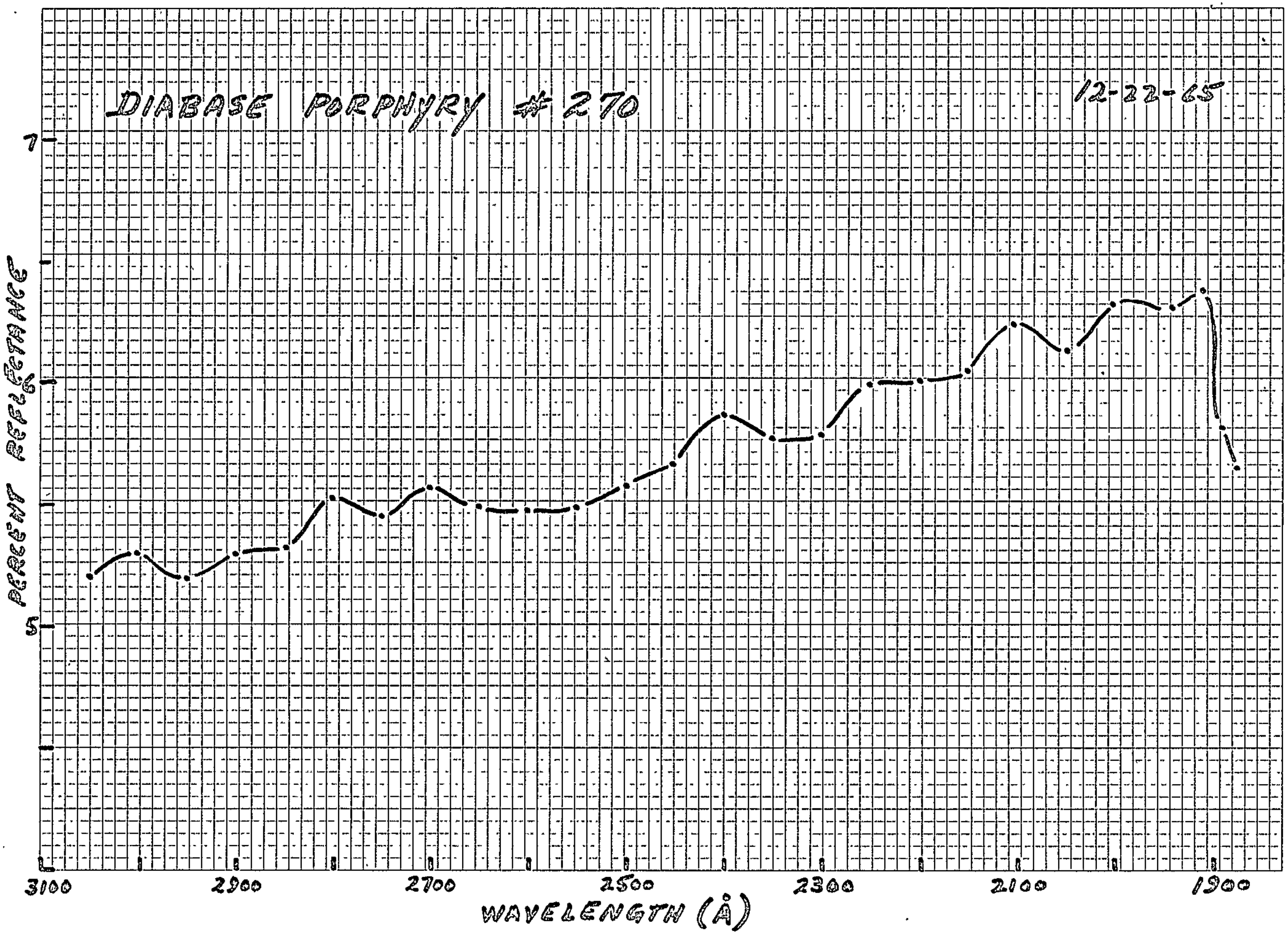


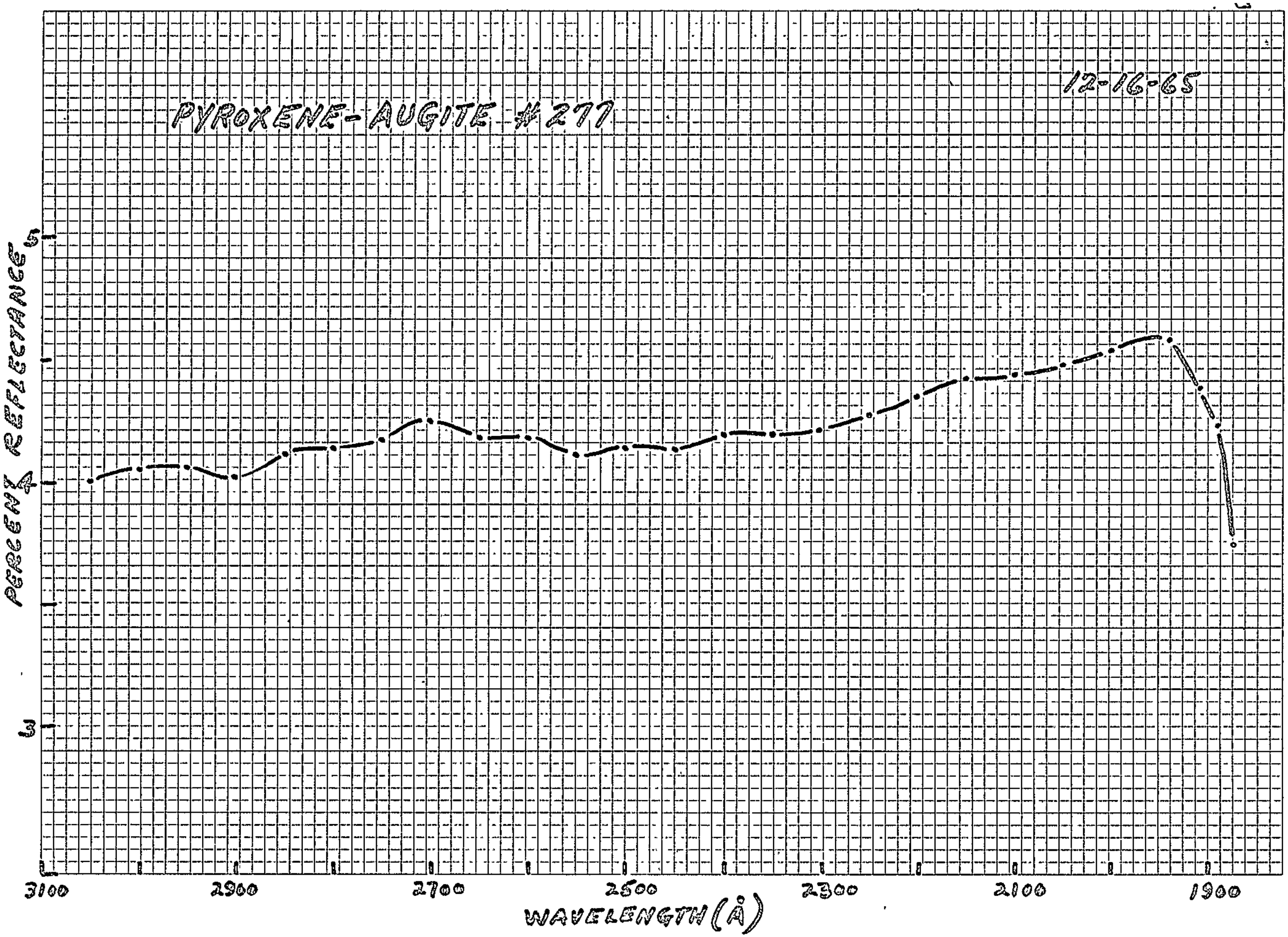


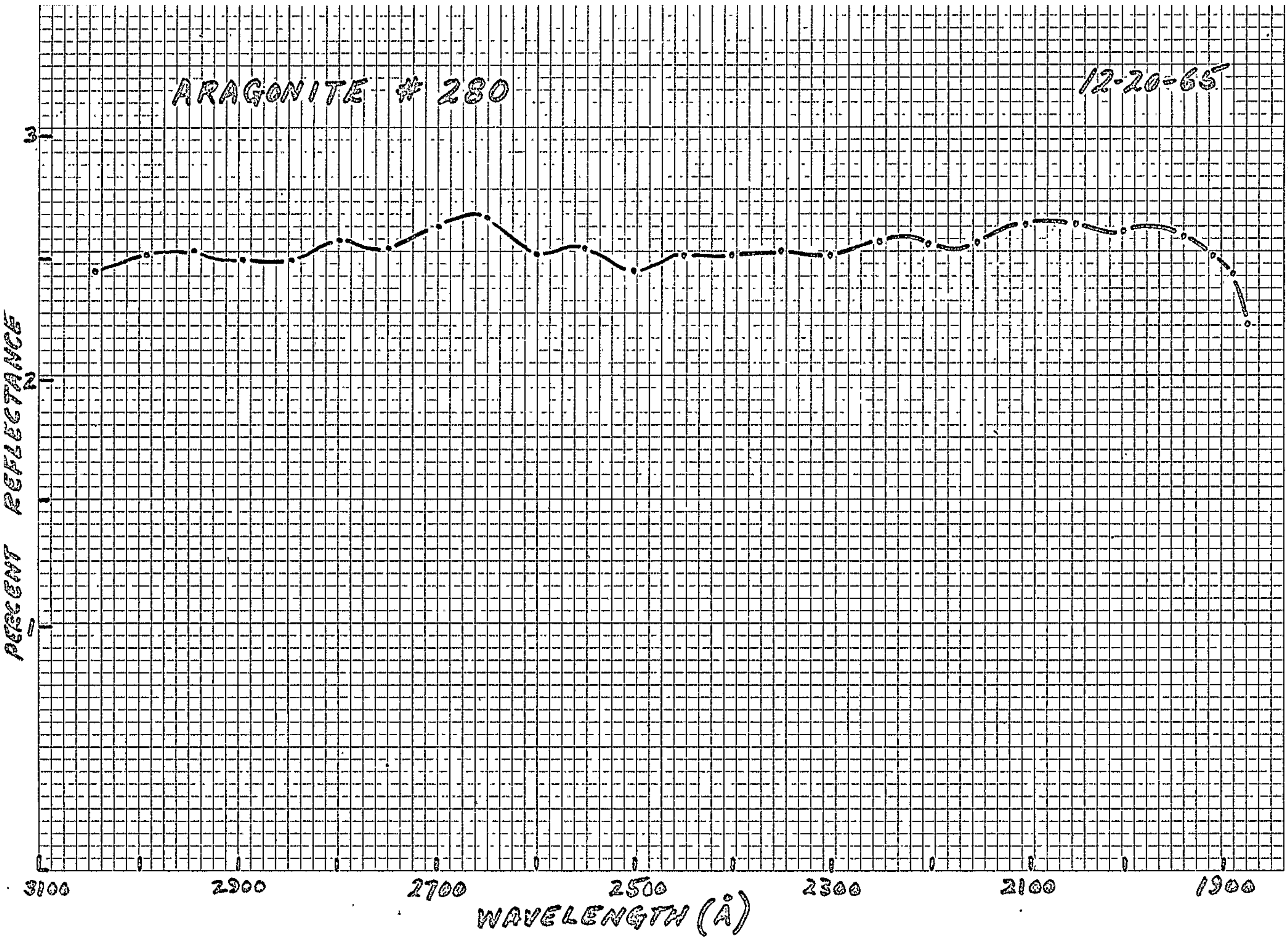


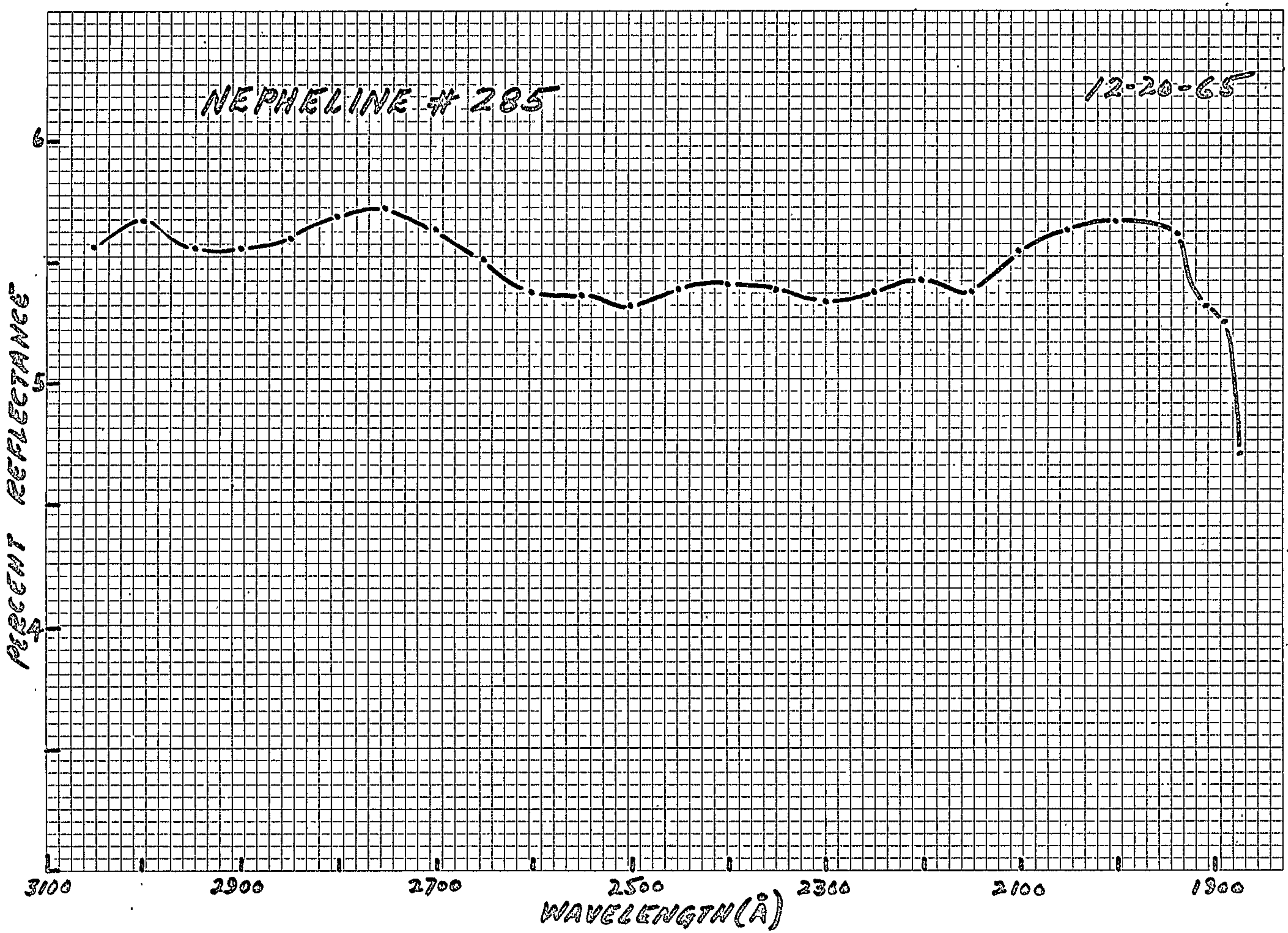


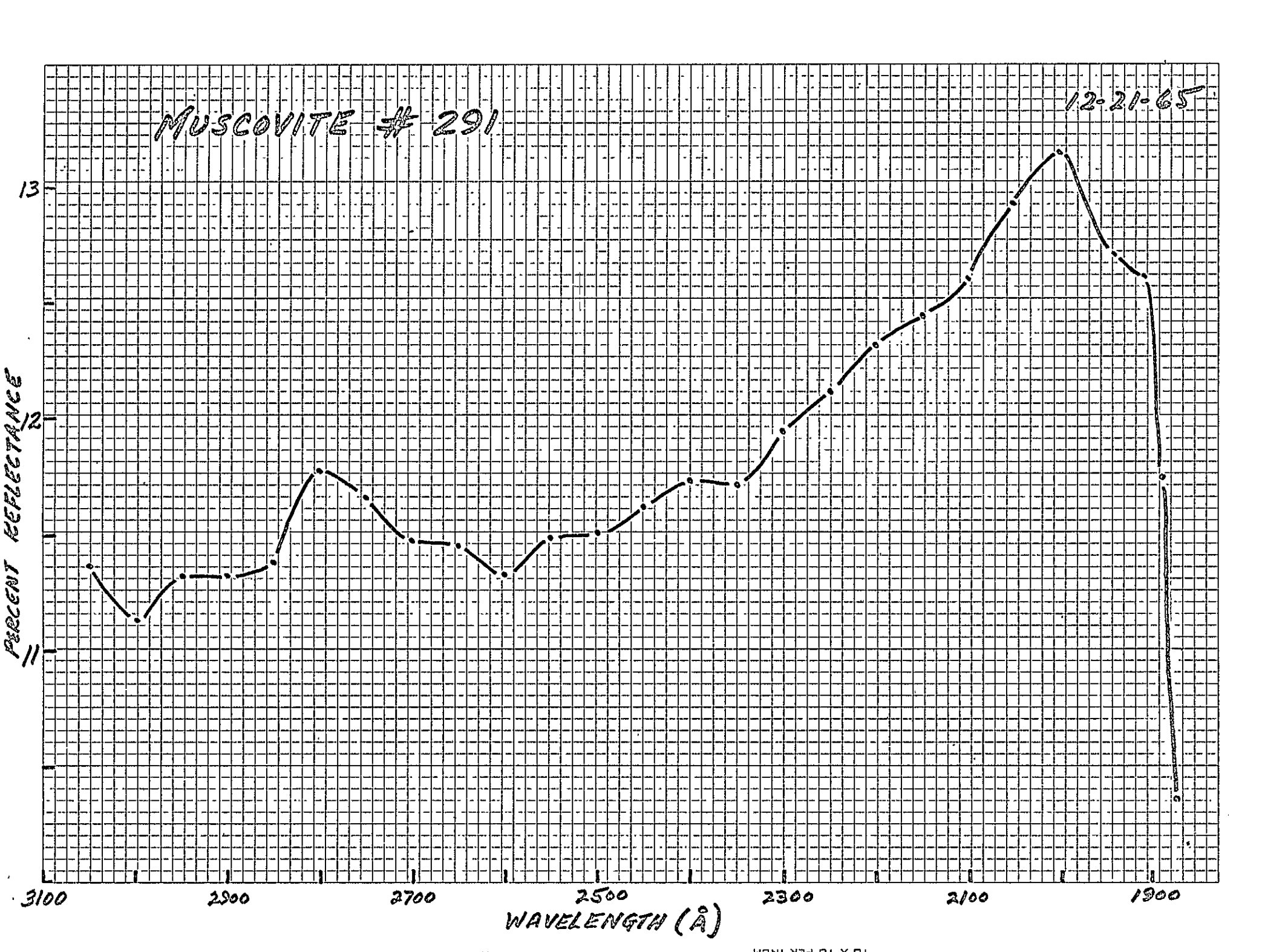


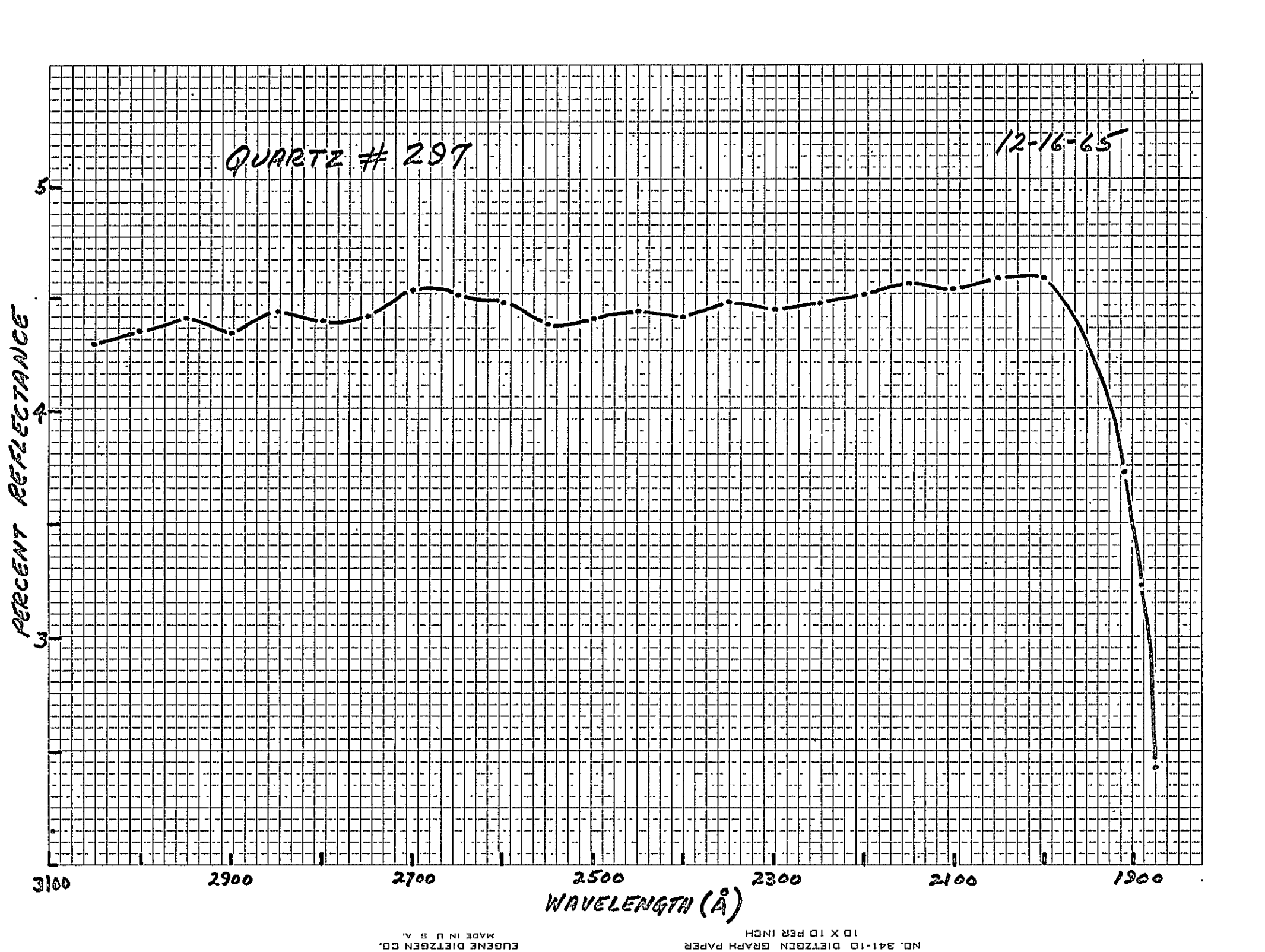


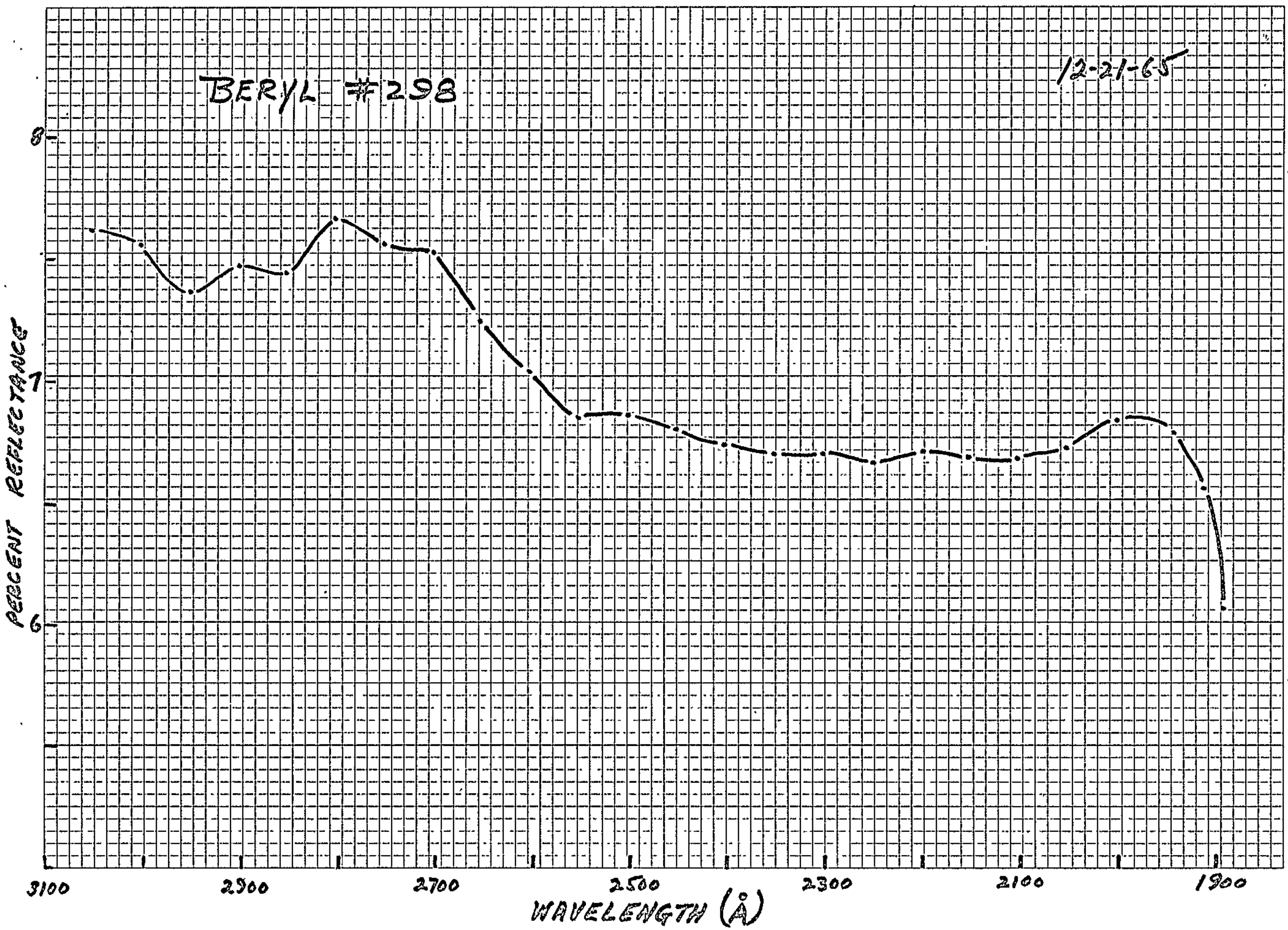


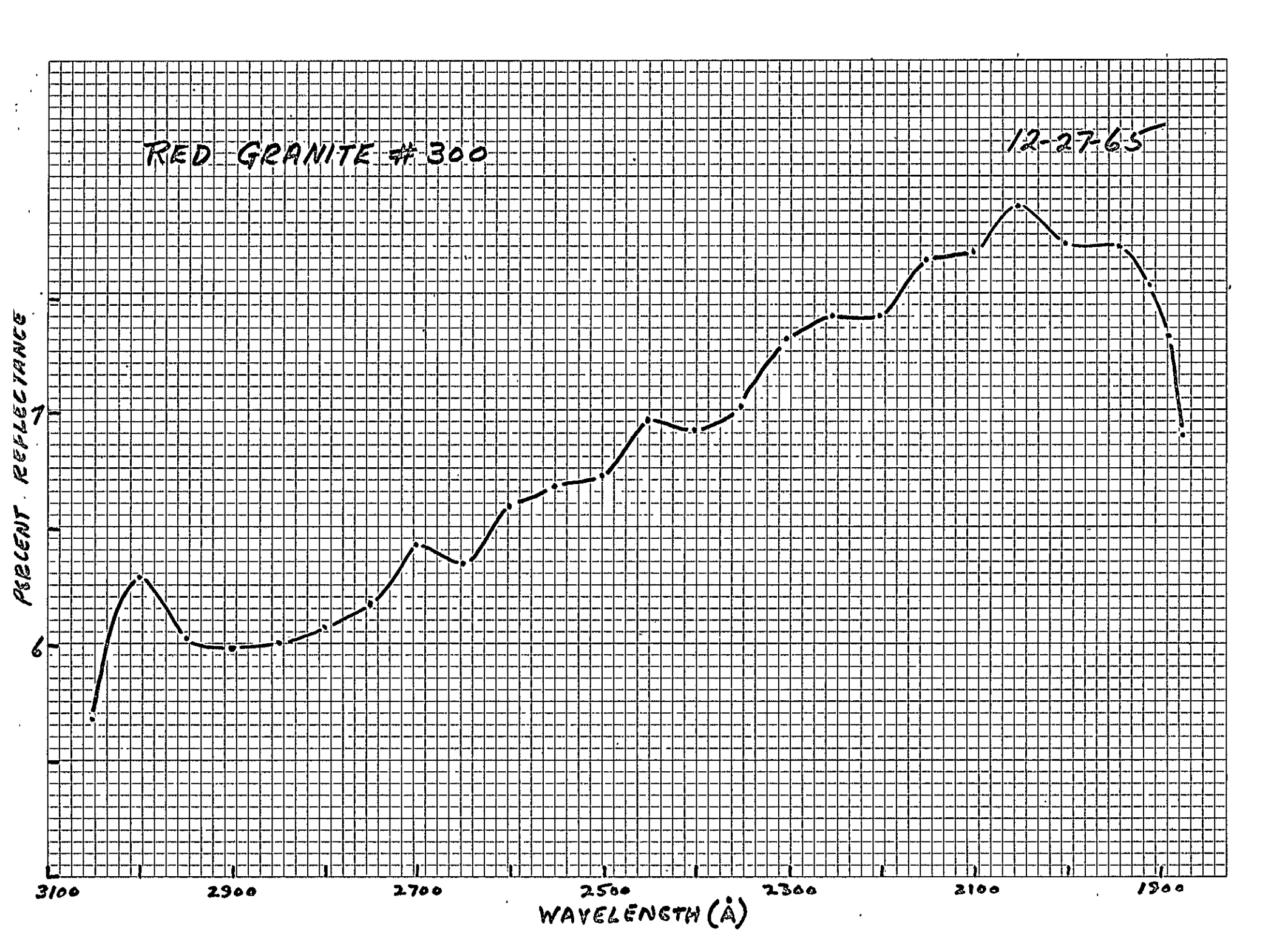


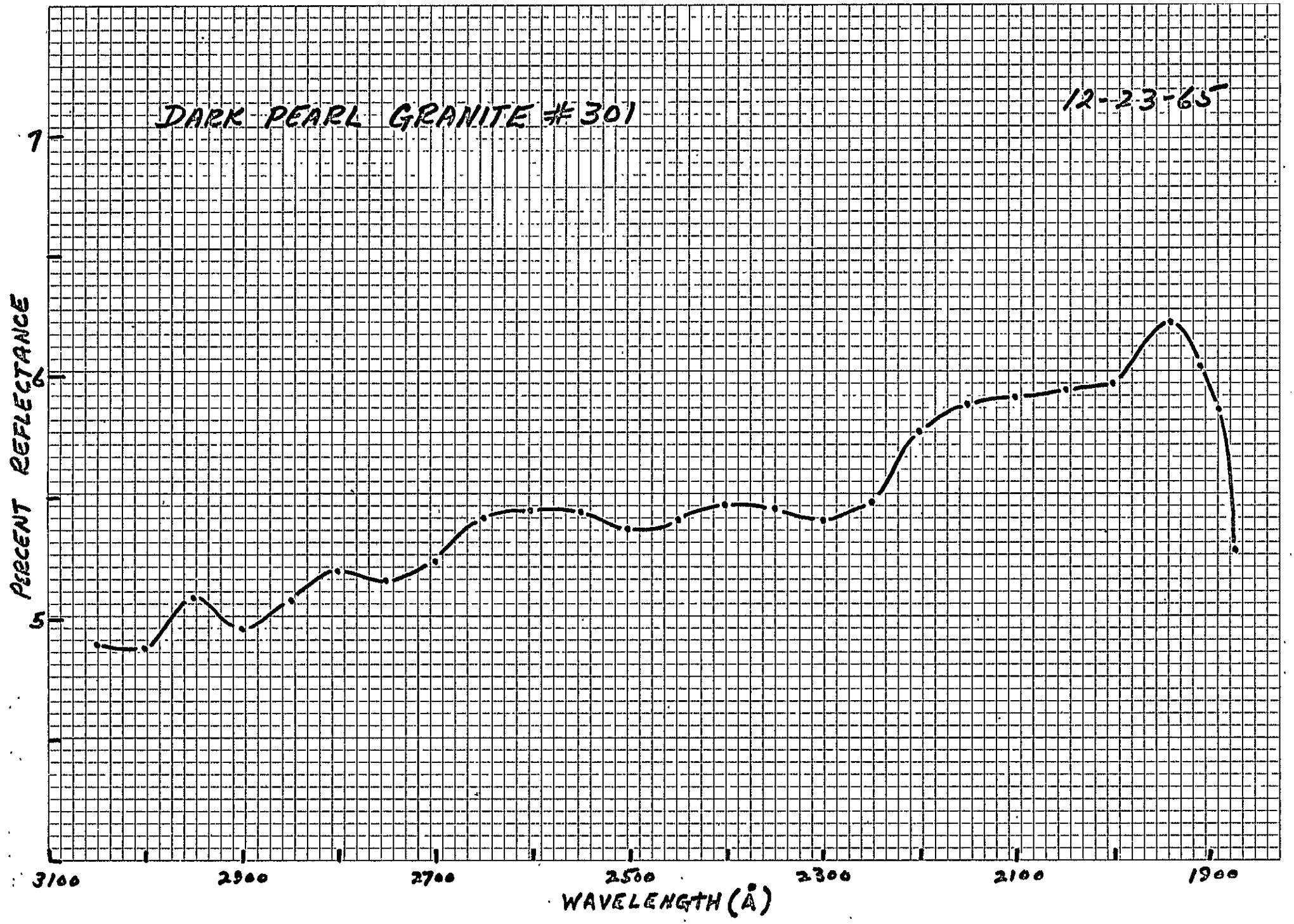


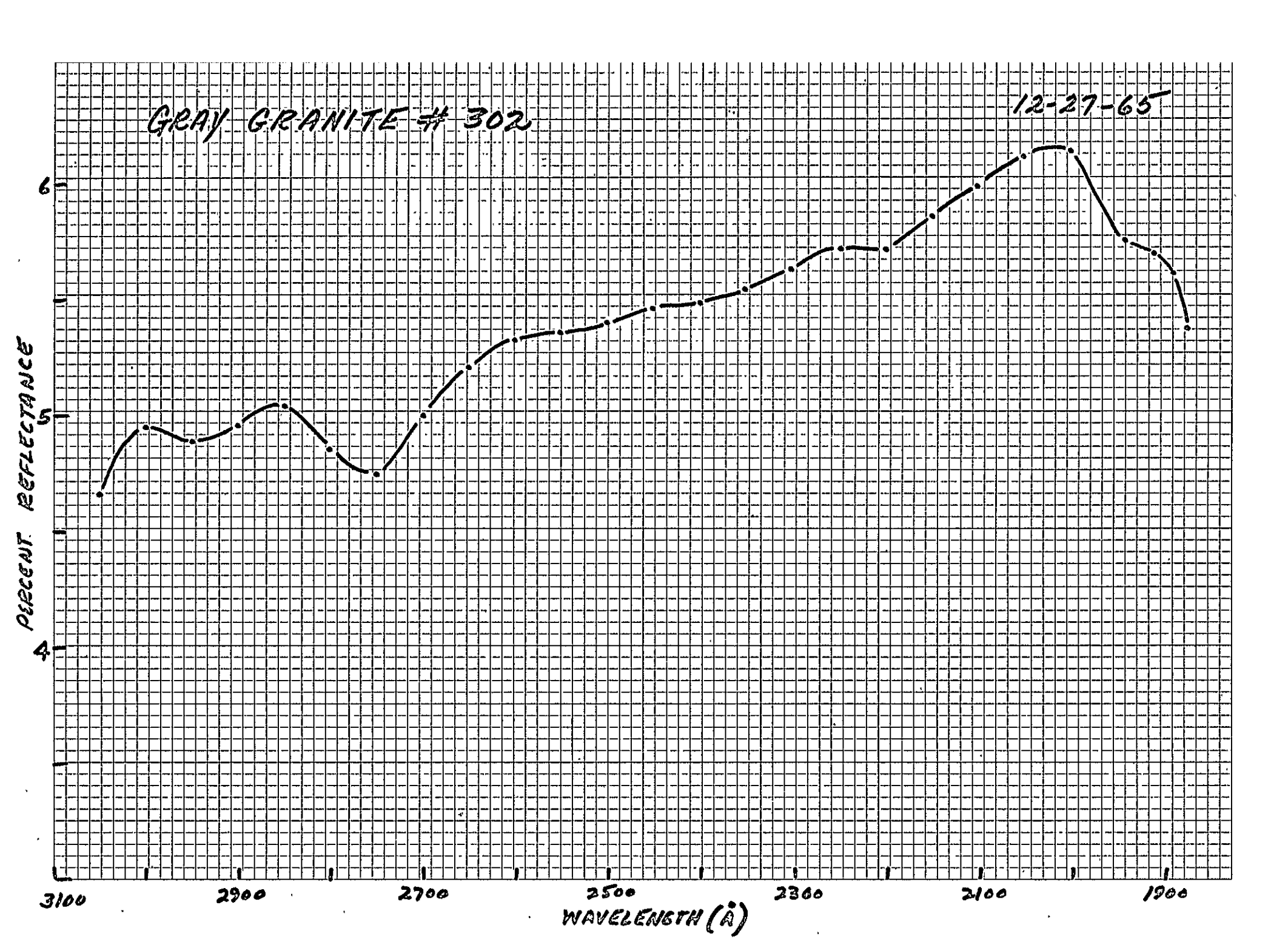


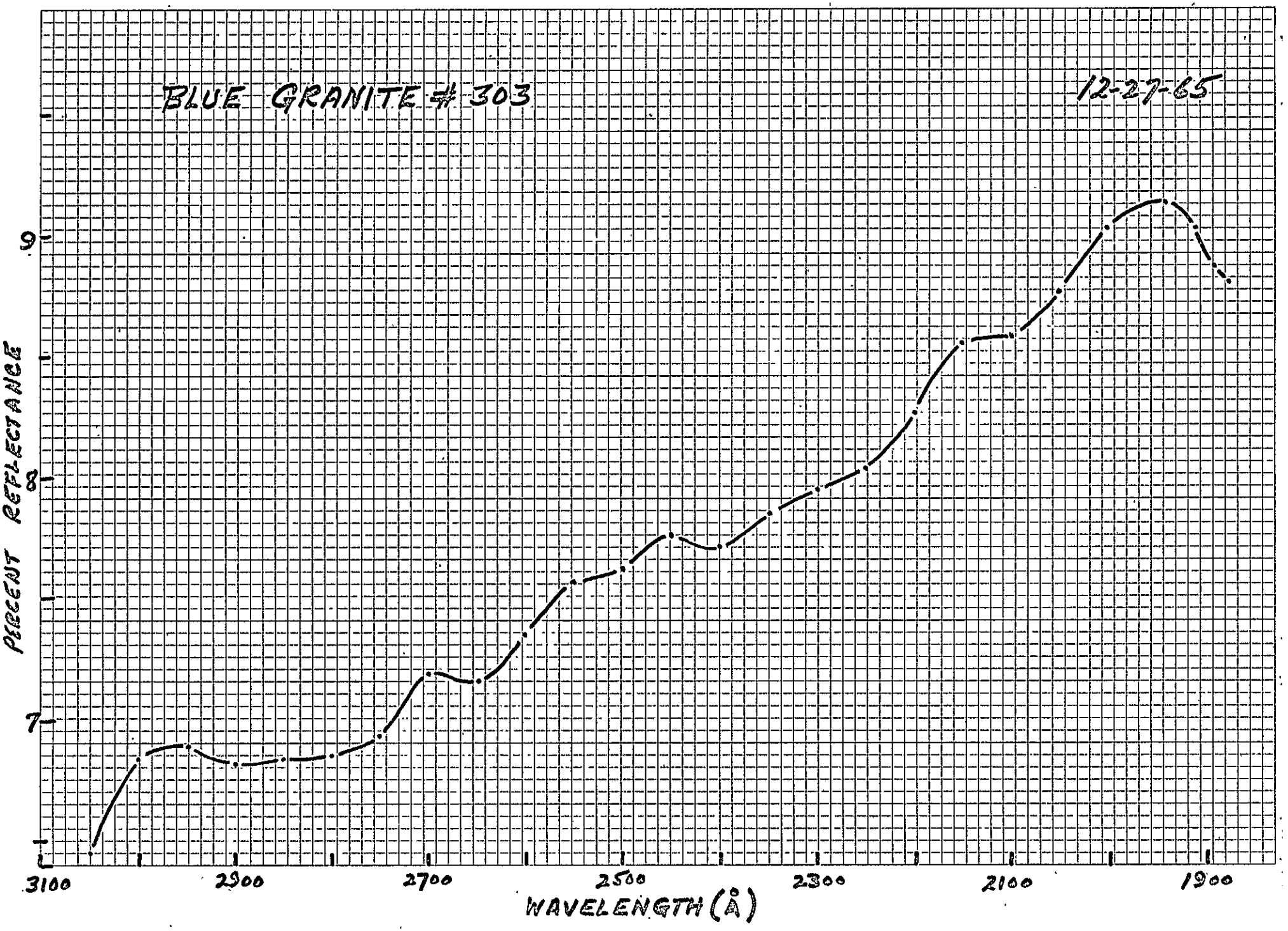


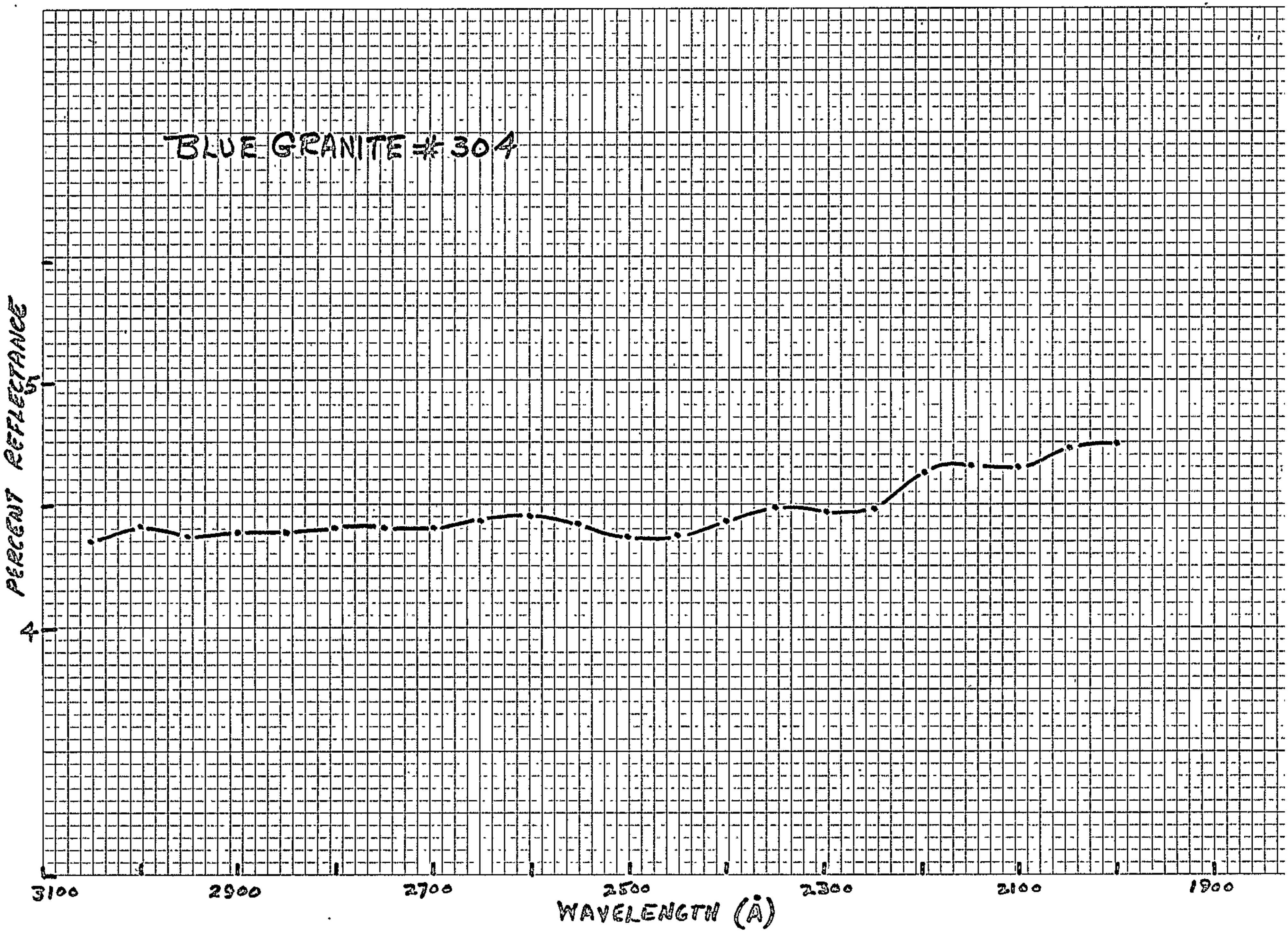


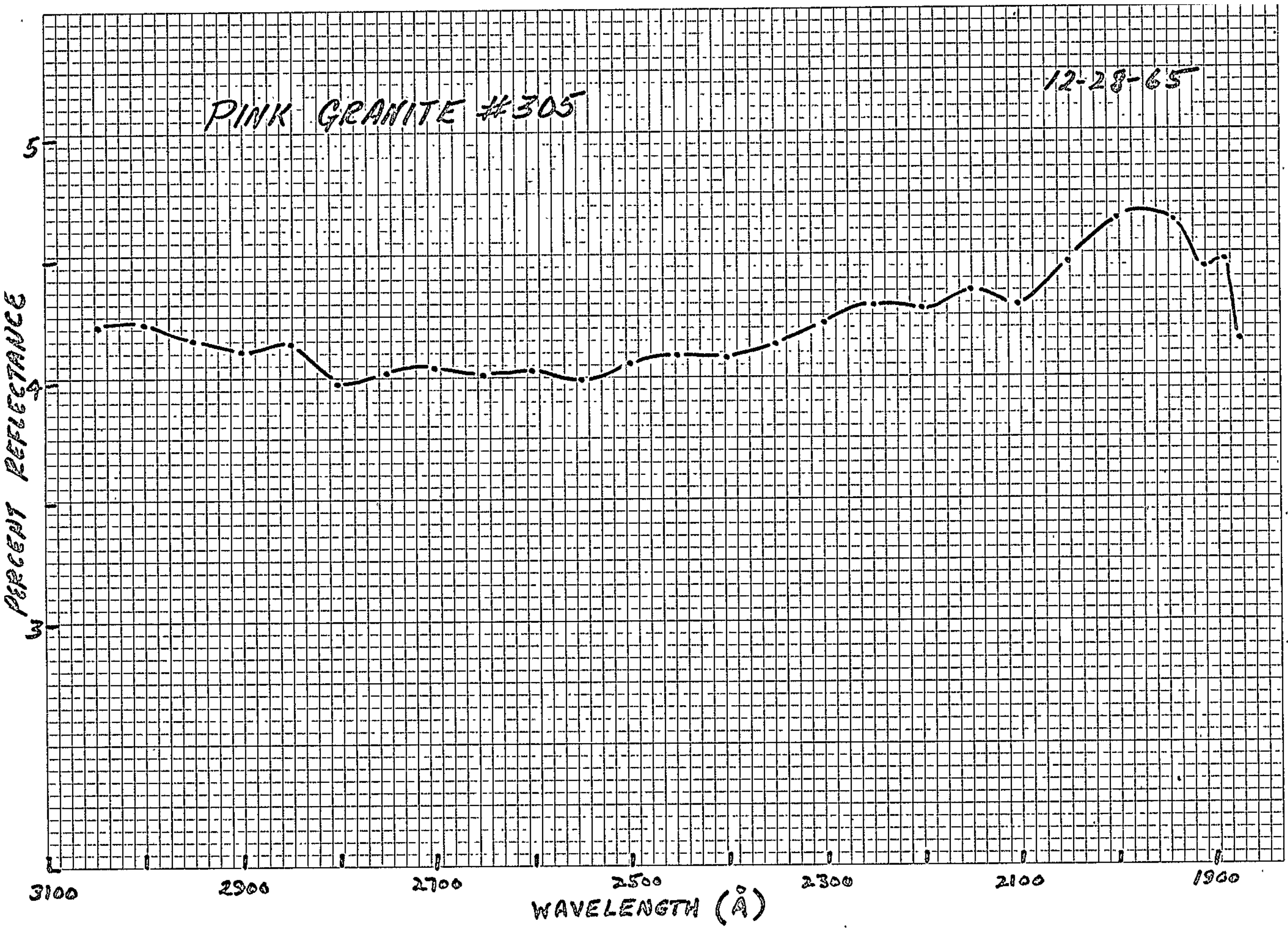


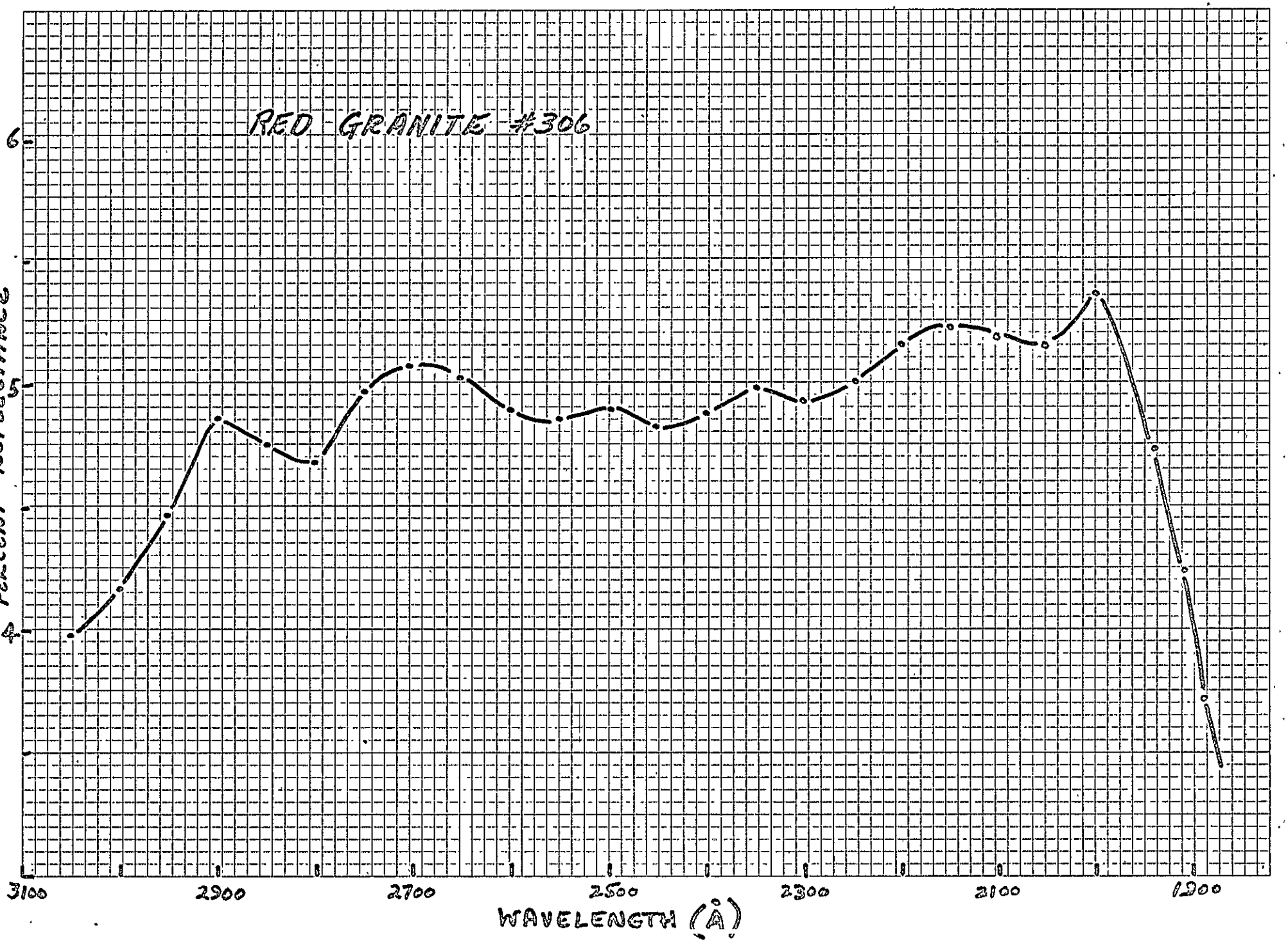


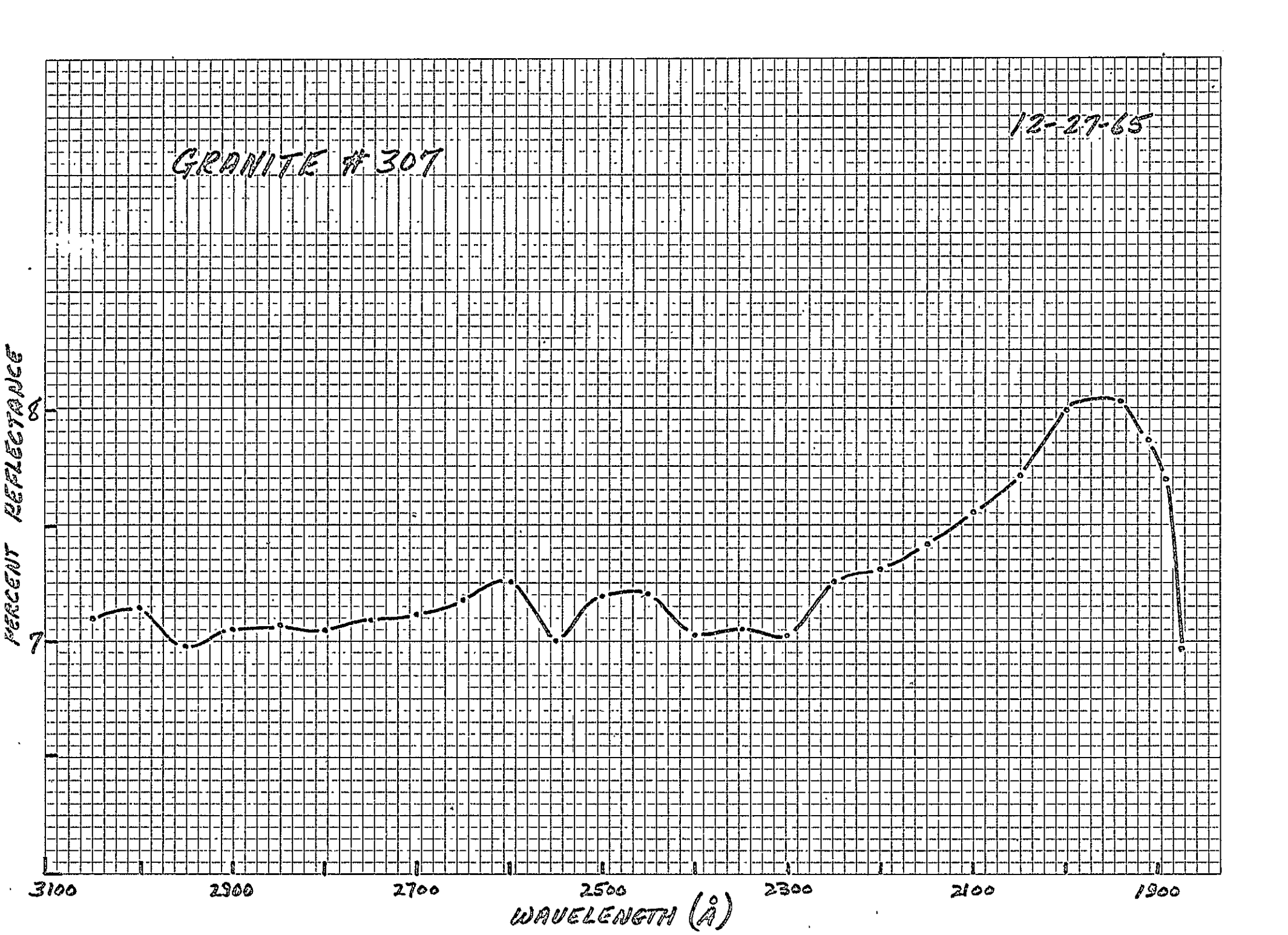


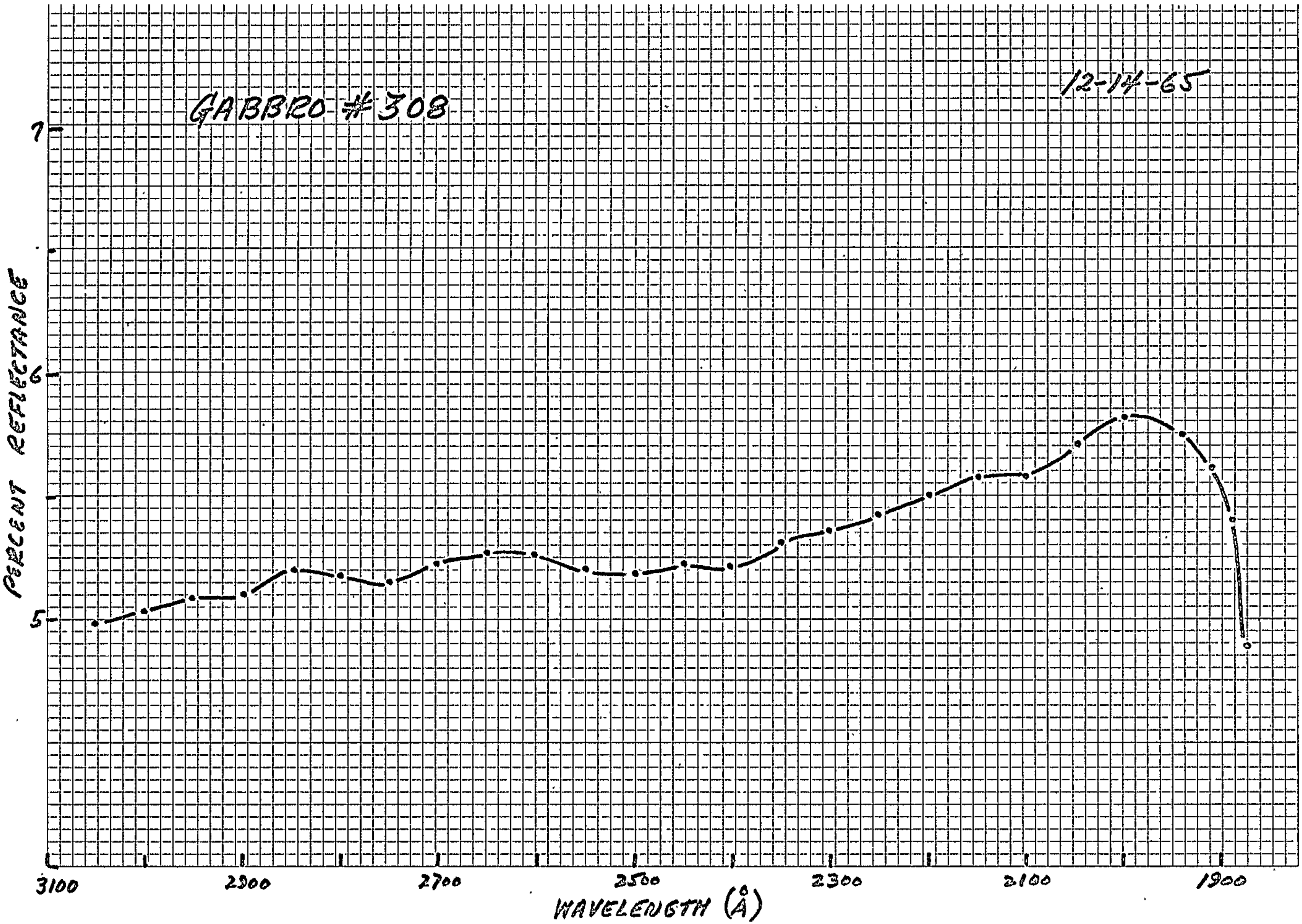


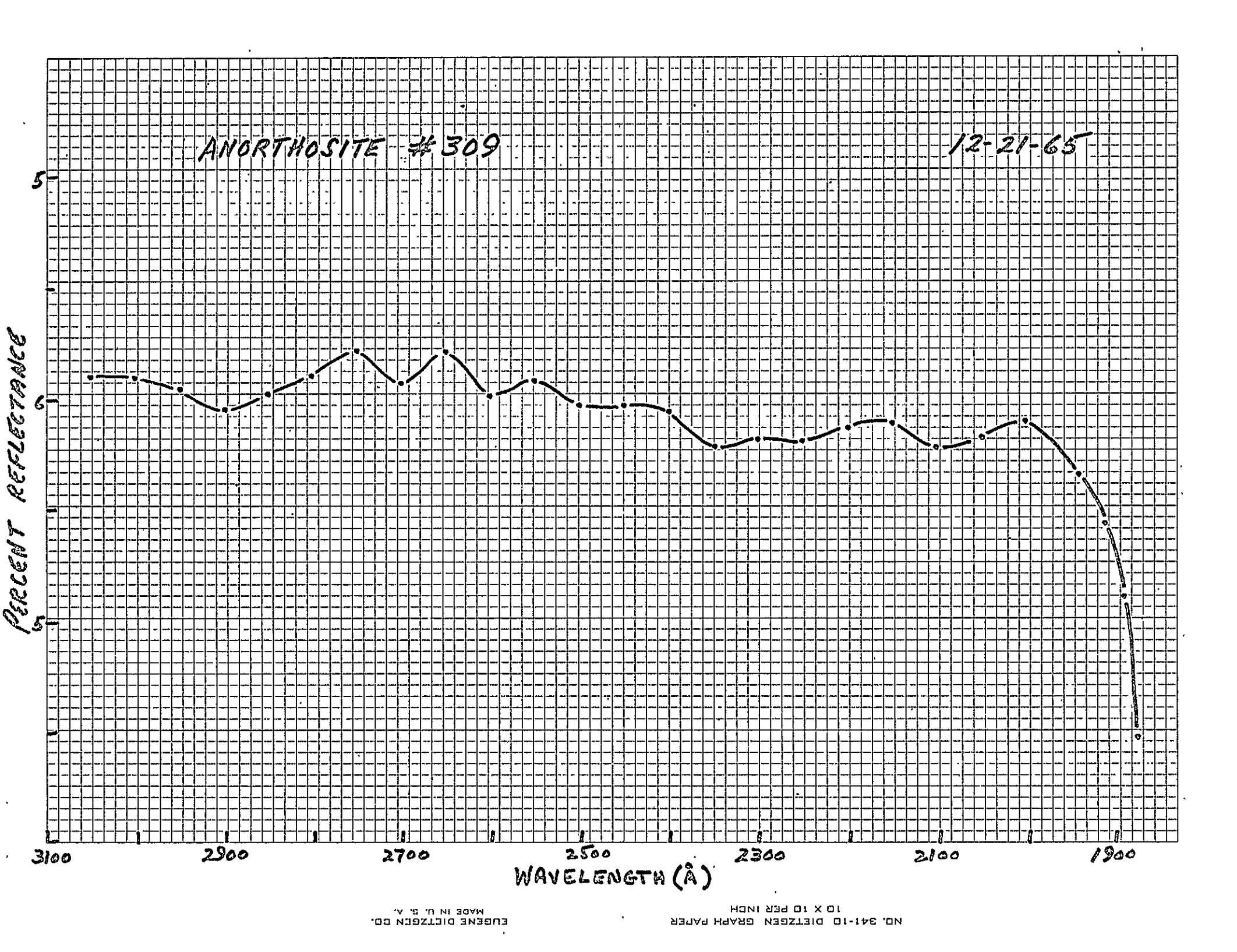


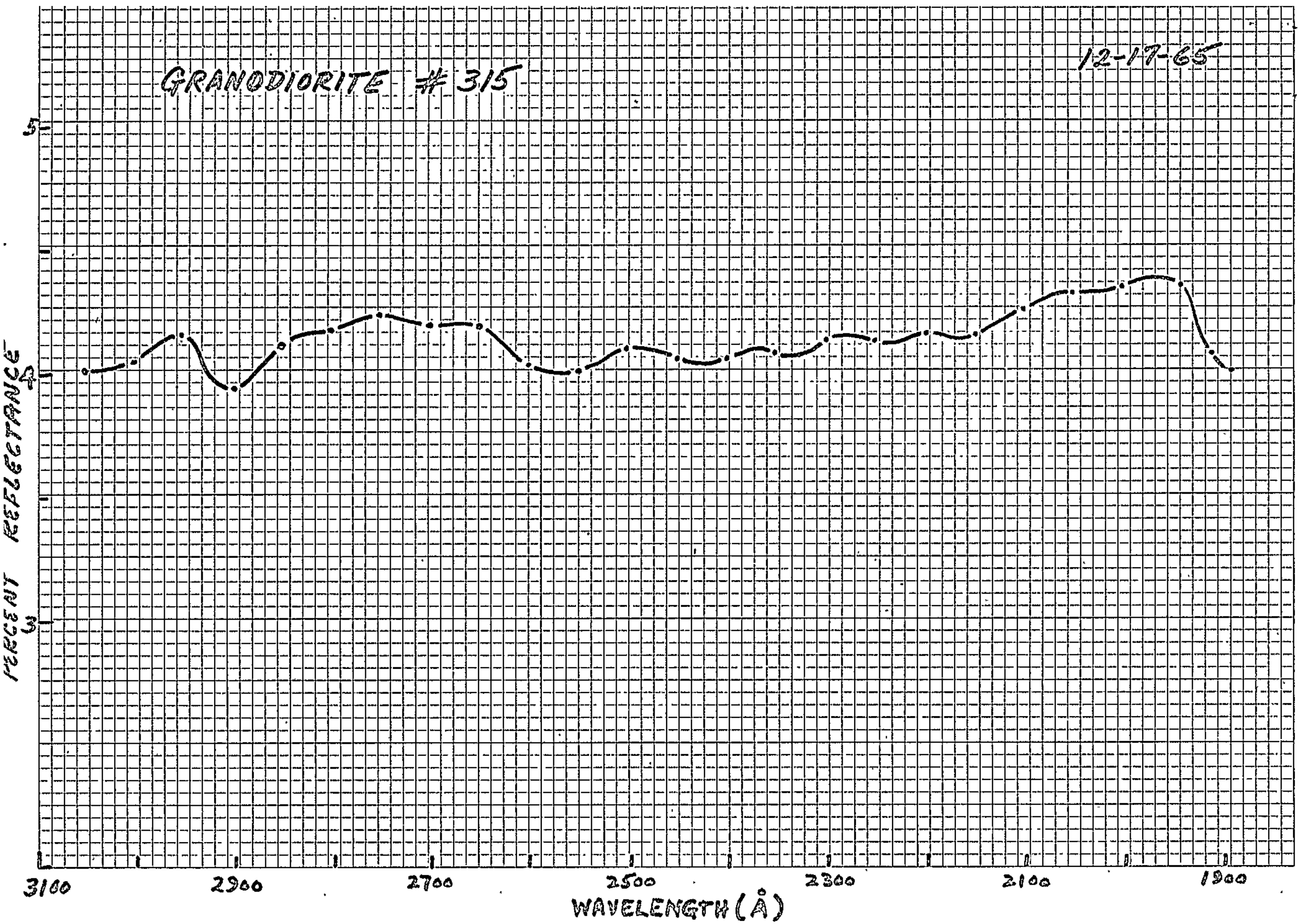


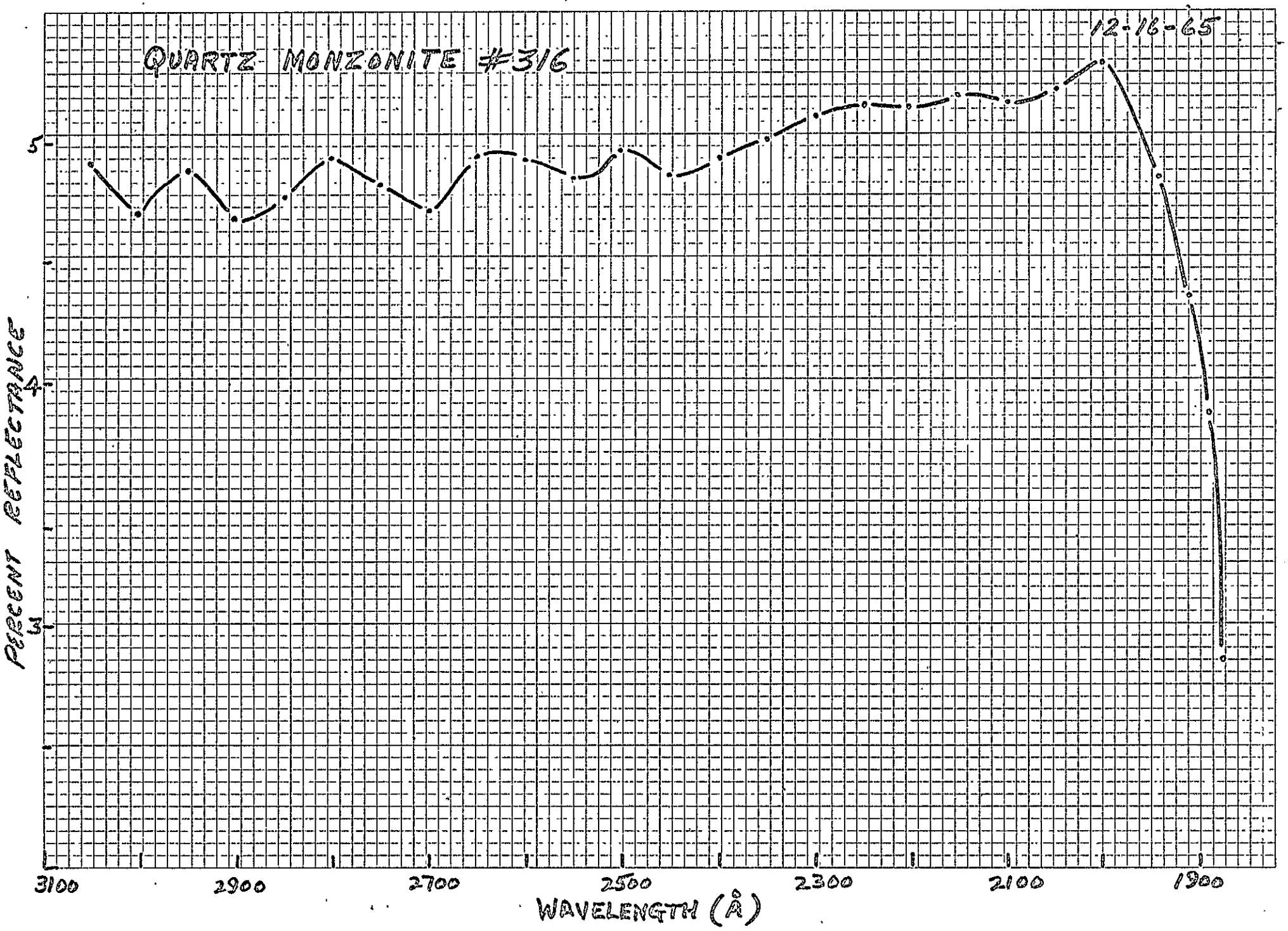


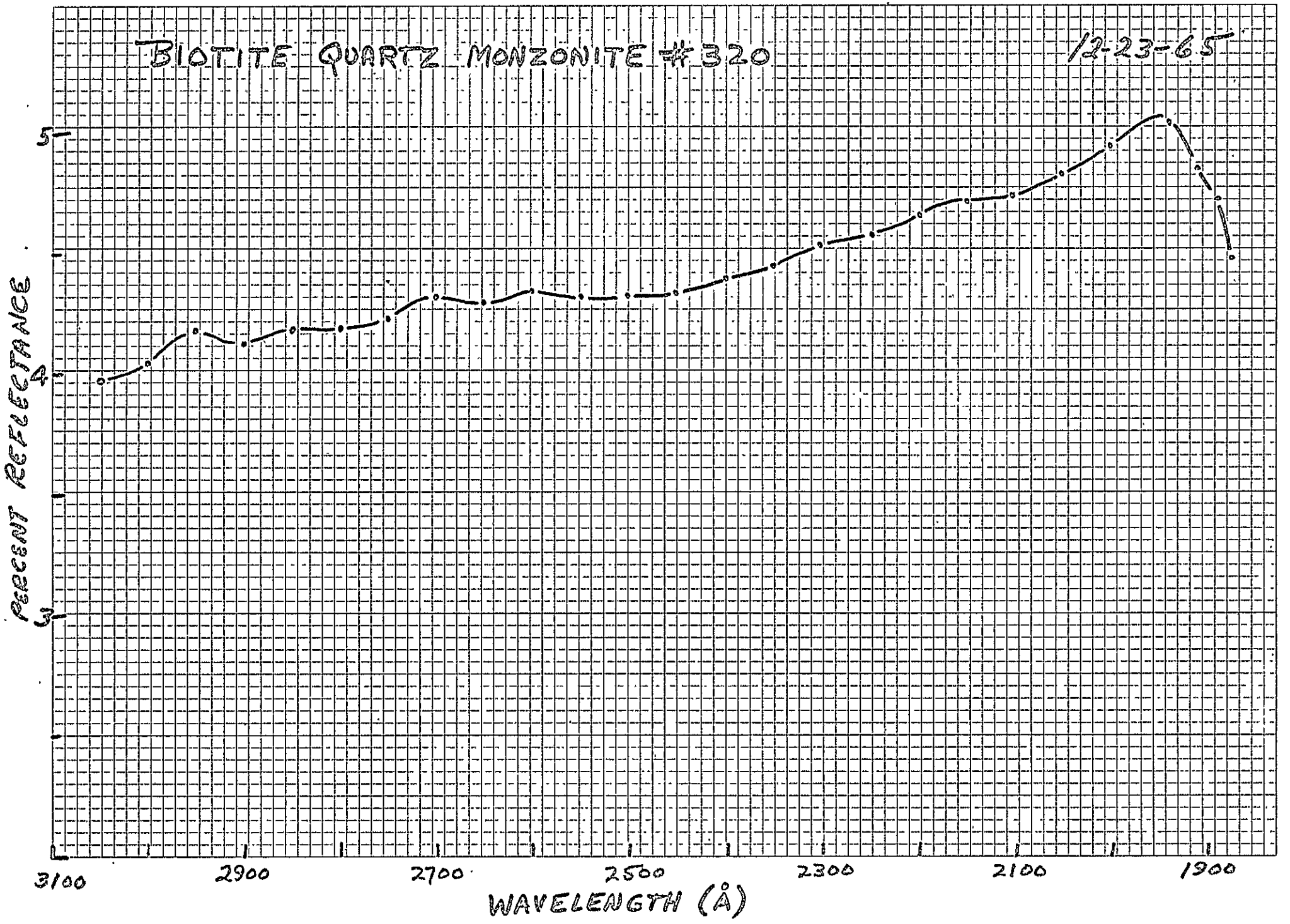


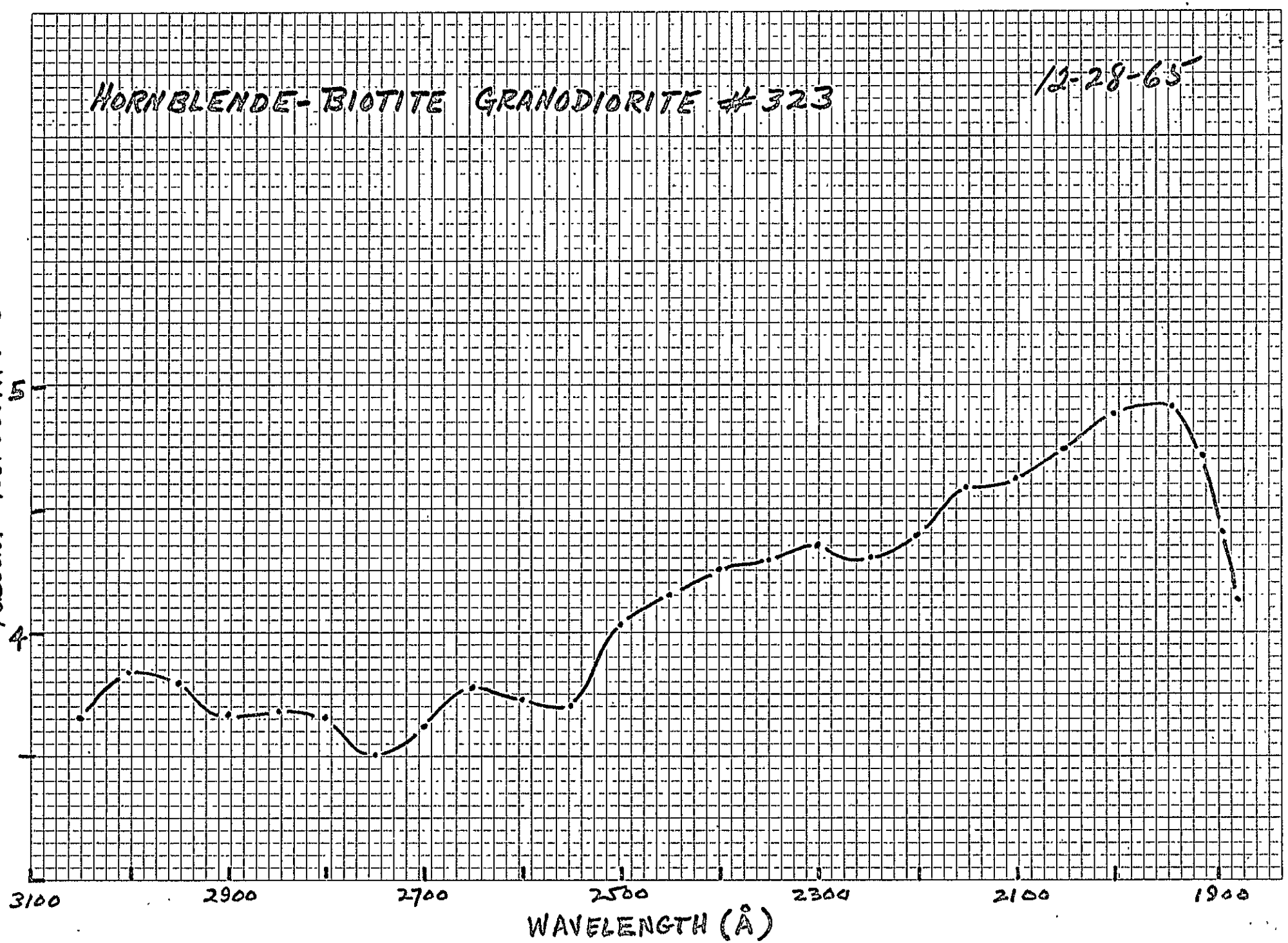


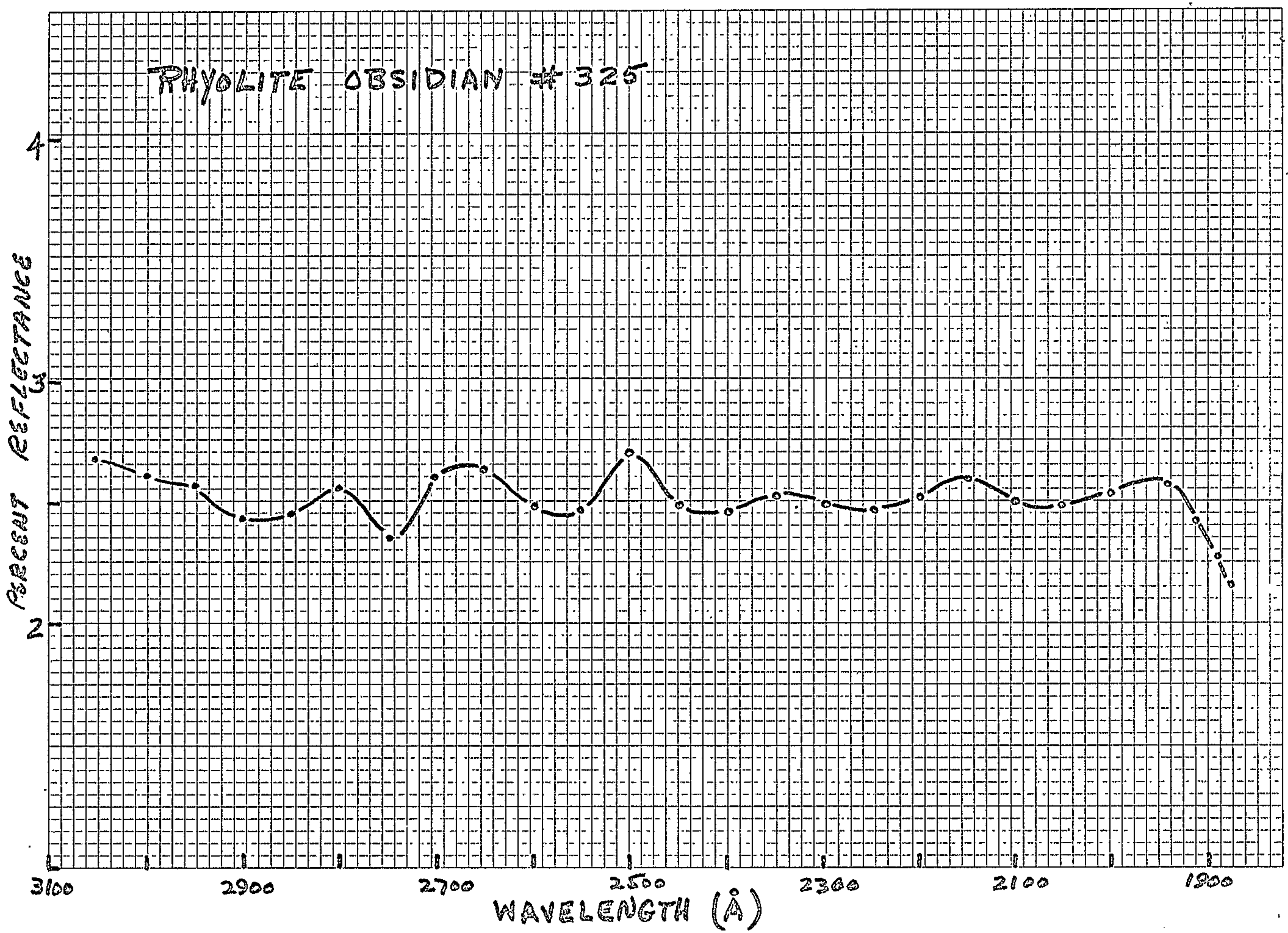


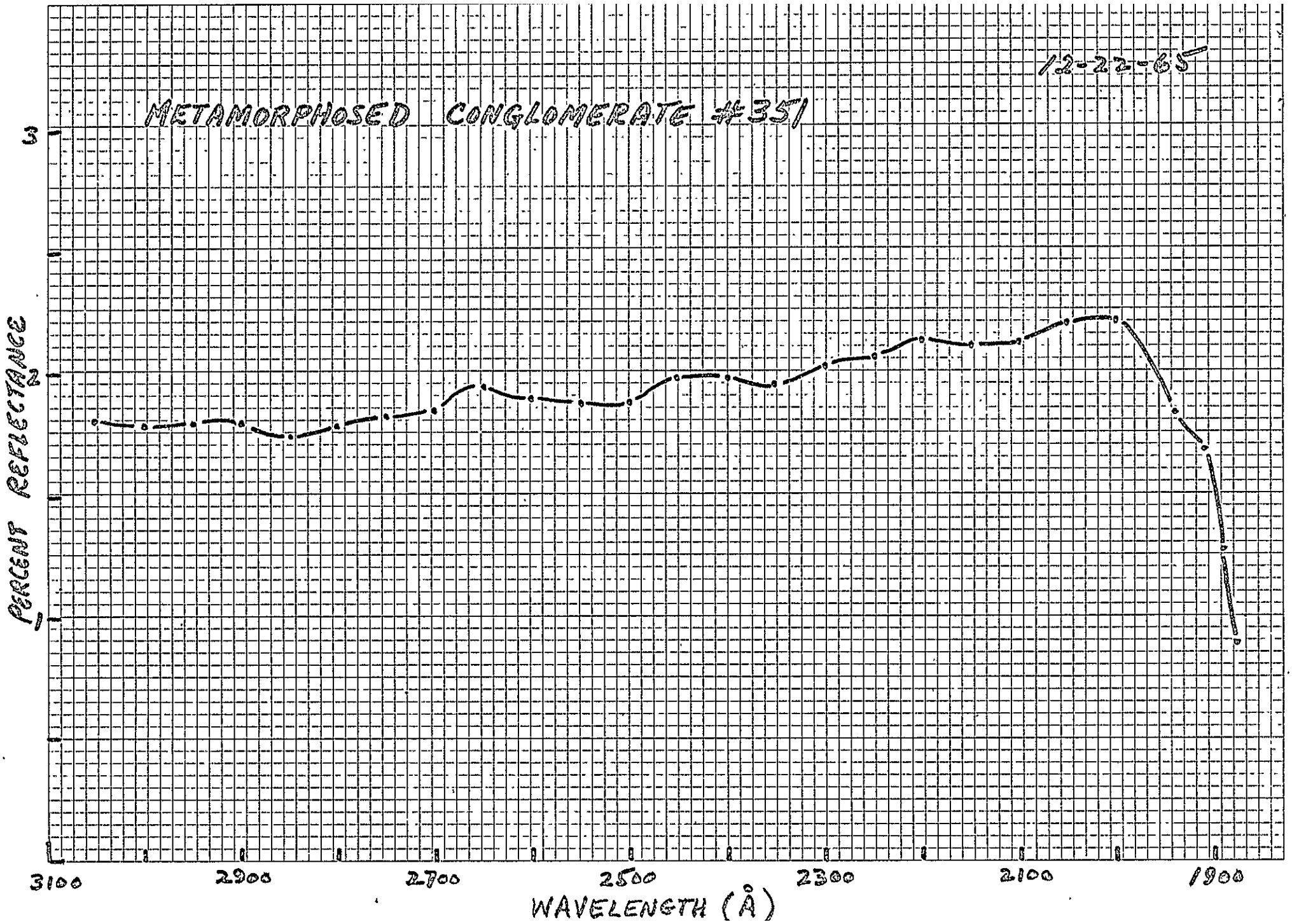


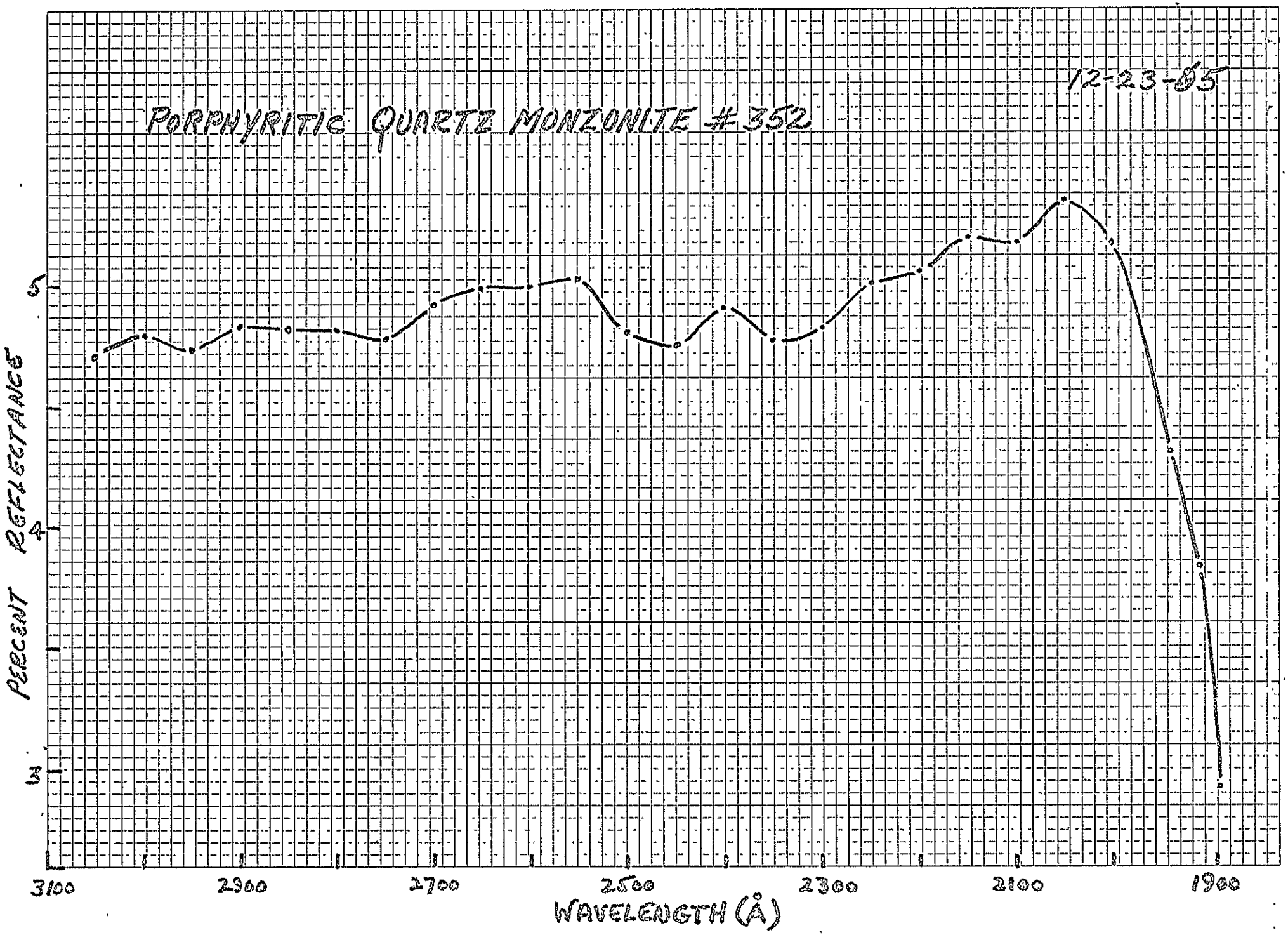


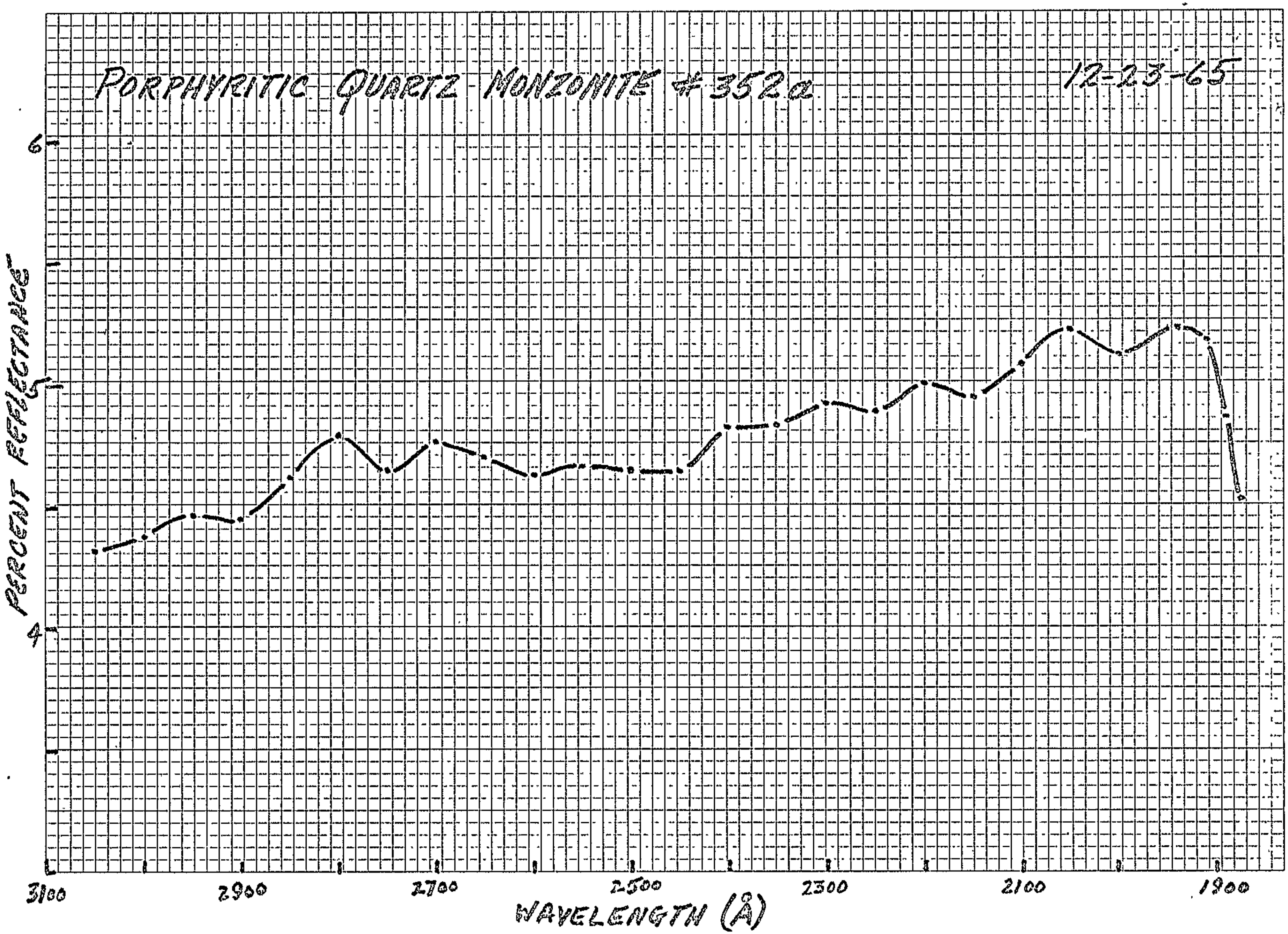


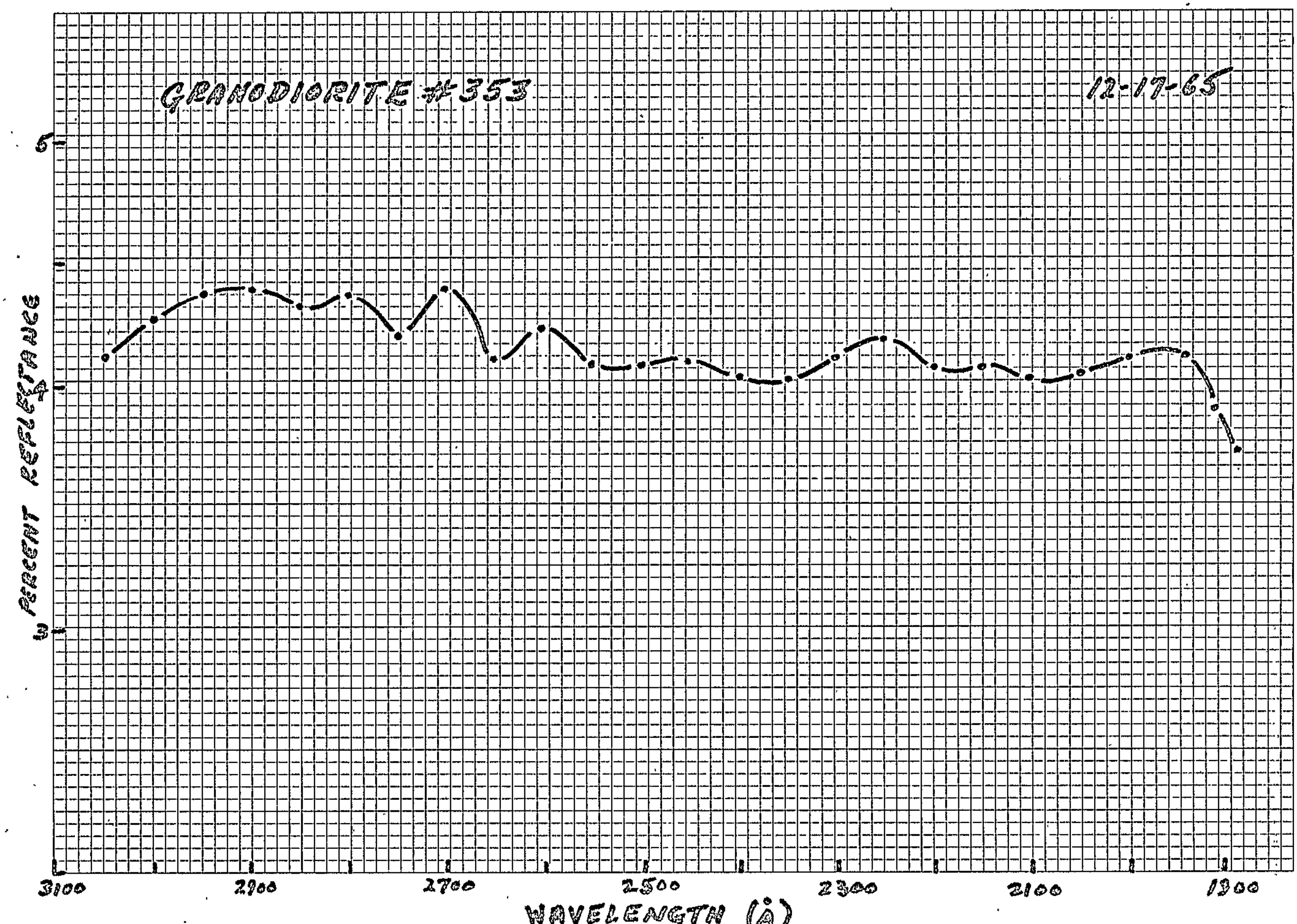


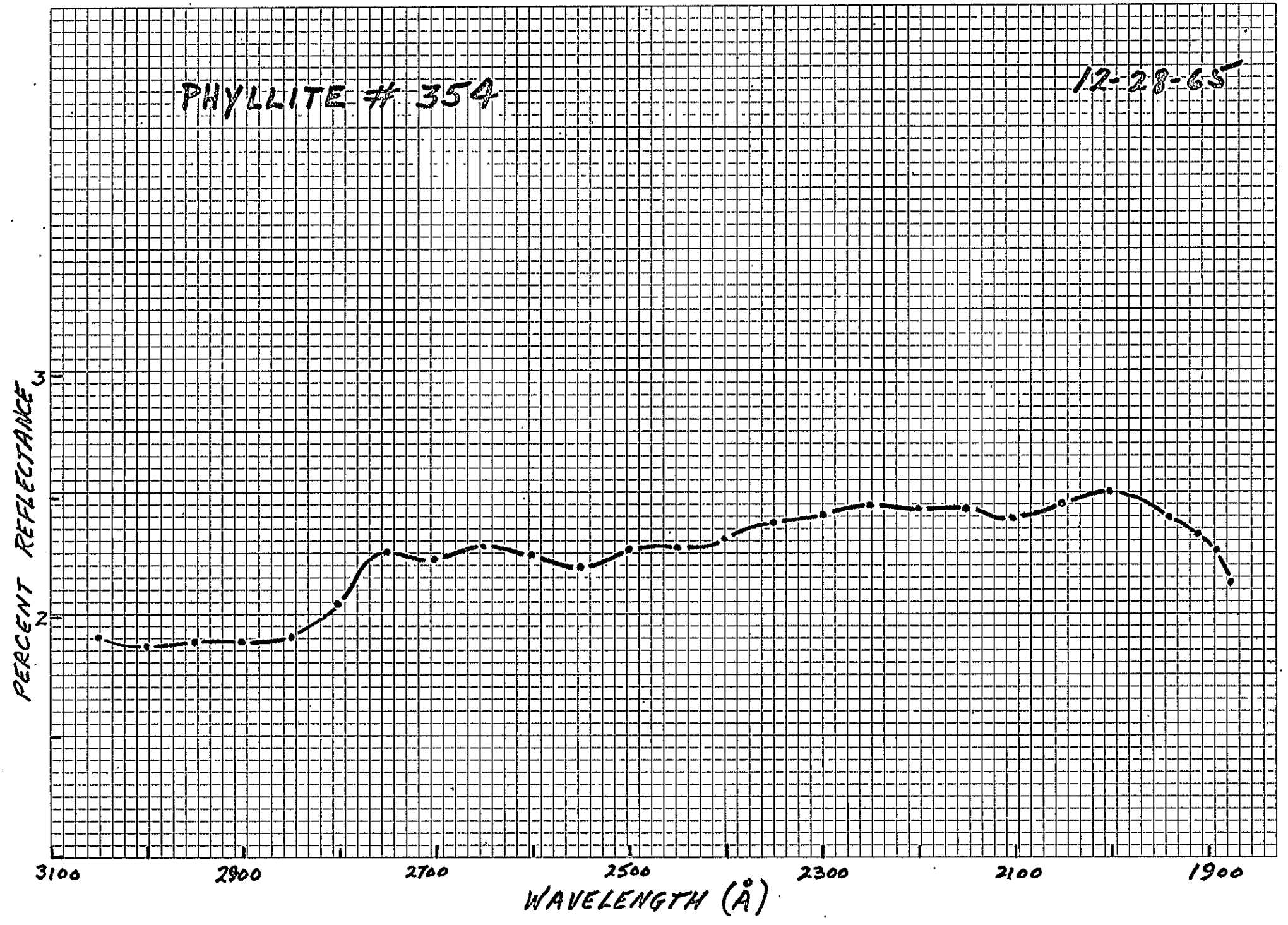


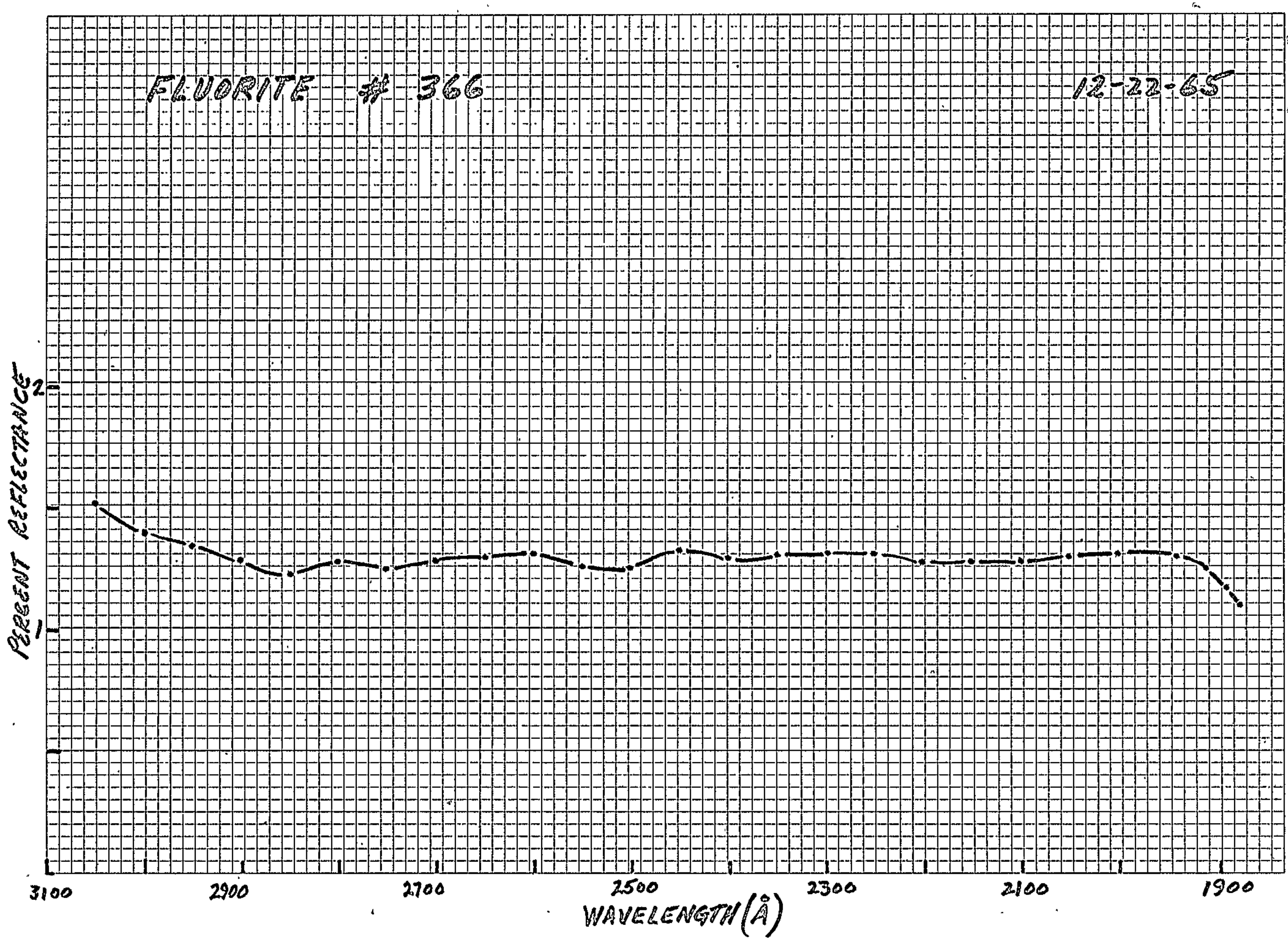








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